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"Sea Mammals" Project 02.05—61 of the USSR-USA Agreement on Cooperation in Environmental Protection

Introduction

This report includes data on the research conducted on sea mammals of the North Pacific during 1986—1987 within the framework of the "Sea Mammals" project 02.05-61 of the USSR-USA Agreement on Cooperation in Environmental Protection.

The various biological, ecological, morphological and other material on sea mammals was collected both in national expeditions, and in joint Soviet-American and American-Soviet expeditions. The following expeditions and stationary investigations have been carried out over the past years:

1. In September—October 1987, a Soviet—American expedition to the Chukchi Sea on the "Zakharovo" hunting and fishing vessel to collect data on the Pacific walrus and ice forms of seals (VNIRO - A.A. Kibalchich; TINRO - V.M. Kogai, O.N. Katugin, A.I. Grachev - Okhotskrybvod, F. Fay -

Institute of Marine Research of the University of Alaska, S. Hills - Department of Fisheries and Wildlife, R. Merrick - National Laboratory of Sea Mammals).

2. In October 1987, Soviet investigators with American specialists from the Habbs Marine Institute continued their study of nonmetric characters in the common seal, as well as the structure of dolphin populations of the genus *Stenella* (IRB AN SSSR - A.V. Yablokov, M.V. Mina; Habbs Marine Institute - B. Stuart, I. Ioham).

3. In October 1987, a Soviet—American expedition to the North Pacific on the "Dobryi" whaler was planned for the purpose of conducting distribution and abundance observations in this part of the ocean. However, ship damage prevented the Americans from taking part in this expedition.

From1986 to 1987, the greatest volume of research was carried out within the national programs:

1. In August—October 1986 and in July—October 1987, aerial surveys were conducted to study the distribution and abundance of whales in the coastal waters of the Sea of Okhotsk (A.A. Berzin, V.L. Vladimirov, N.V. Doroshenko - TINRO).

2. In June—October 1986, a whale survey was conducted from the "Tungus" research vessel in the coastal zone of the Sea of Okhotsk and Bering Sea, as well as along the Kurile chain of islands (S.A. Blokhin - TINRO).

3. In 1986 and 1987, an aerial survey of the abundance of ice seals was carried out in the Karaginsky Gulf of the Bering Sea (V.N. Burkanov, A.G. Semenov, S.A. Mashagin, Ye.V. Karayev - Kamchatrybvod).

4. In 1986, a summer—autumn survey of coastal seal rookeries was carried out in the Sea of Okhotsk (S.I. Lagerev - TINRO).

5. Investigations on the harbour seal of Peter the Great Gulf were carried out (A.M. Trukhin, G.M. Kosygin - TINRO).

6. Data on the comparative characteristics of the mass of the skeleton and its elements in the harbour seal and Kuril seal were analyzed (A.Ye. Kuzin - TINRO).

7. Data on some of the factors that reduce the abundance of the brood stock of salmons were obtained in August—September 1987 (A.I. Makhnyr, A.S. Perlov - TINRO)

8. An aerial survey of ice seals of the Bering Sea and the Pacific walrus was carried out in April—May 1987 (G.A. Fedoseyev, Ye.V. Razlivalov, G.G. Bobrova - Magadan branch of TINRO).

9. The 1978—1987 observations on the distribution and abundance of the northern sea-lions on the Commander Isls. were summed up (V.V. Vertyankin, V.S. Nikulin - Kamchatrybvod).

10. The 1982-1987 data on the distribution and abundance of the coastal rookeries of the Pacific walrus on the Kamchatka Peninsula were correlated (A.R. Semenov, V.N. Burkanov, S.A. Mashagin - Kamchatrybvod).

11. The walrus data from the "Zakharovo" expedition in March—April 1985 were correlated (A.A. Kibalchich - VNIRO).

12. The 1982—1987 data on various questions related to the ecology of the walrus from the Anadyr Gulf were correlated (A.I. Grachev - Okhotskrybvod).

13. The walrus rookeries on Russkaya Koshka in the Bering Sea were described (G.P. Smirnov - Okhotskrybvod).

14. Data on the seasonal and diurnal dynamics of walrus abundance were obtained on the basis of a number of coastal rookeries in the Bering Sea (N.I. Mymrin, G.P. Smirnov, A.S. Gayevsky, A.I. Grachev, Yu.V. Klimenko - Okhotskrybvod).

15. Morphometric analysis of the linear size and proportions of the turtles from the waters separating the Commander Isls. and the Kamchatka Peninsula was carried out (A.M. Burdin - Kamchatka branch of TINRO).

16. The results of the tagging of sea otters on the Commander Isls. during 1986—1987 were summed up (V.F. Sevostyanov, N.P. Zimenko, P.A. Ryazanov, I.N. Shevchenko - Commander Scientific Group of KoTINRO).

17. Long-term data on the dynamics of sea-otter abundance and feeding on the Kurile Isls. were correlated (M.K. Maminov - TINRO).

18. The 1984-1987 data on the dynamics of sea-otter abundance in the southern part of Kamchatka were correlated (S.I. Kornev, S.M. Korneva - Kamchatrybvod).

SEA MAMMAL RESEARCH IN 1986—1987

by L.A. Popov (VNIRO)

The research on the sea mammals of the North Pacific, carried on within the framework of the "Sea Mammals" project 02.05—61 of the USSR—USA Agreement on Cooperation in Environmental Protection in 1986—1987, were conducted in the region of the Chukchi Sea in the north and up to the Kurile Isls. and the coast of California in the south. During this period, 19 expeditions and stationary investigations (16 national, 2 Soviet—American and one American—Soviet) were carried out; the participants from the Soviet side included specialists of the sea mammal laboratories of VNIRO, TINRO, MoTINRO, KoTINRO, IBR AN SSSR, and from the American side specialists from various US universities, the Fish and Wildlife Department of Alaska, the US Department of Fish and Wildlife, the National Laboratory of Sea Mammals, the Habbs Marine Institute, etc.

Cetaceans. A research expedition on the "Dobryi" whaler to the pre-Aleutian waters of the Bering Sea and the Pacific Ocean took place in October—December 1987. The research program was to cover the region of the Aleutian Isls. and Bristol Bay in order to observe the distribution of whales and, at the same time, record their abundance. The largest number of whales (finback whales, humpback whales) was encountered in Bristol Bay. There were practically no whales at all in the vicinity of the Aleutian Isls., with the exception of a small group of sperm whales in Amchitka Bay. No Atlantic right whales or blue whales were encountered. Over a period of three days, 45 gray whales were spotted in the eastern part of the Bering Sea; Minke whales were rare, and only one sei whale was encountered in the vicinity of Simushir Is. Ninety killer whales were recorded during the entire period of the expedition.

During 1986—1987, aerial surveys were conducted to study the distribution and abundance of cetaceans in the coastal regions of the Sea of Okhotsk.

Bowhead whales. In July 1987, forty-seven bowhead whales were encountered in Konstantin Bay, and in October they were already in Ulbansk Bay. At the beginning of June 1986, bowhead whales were seen in the vicinity of Gizhiga Bay, singly and in groups.

White whale (beluga). A survey of the white whale was conducted over a period of several days in August and October 1986. The data obtained on its abundance are not reliable enough, since the observations coincided with the end of the migration of summer chum, and the autumn run had not yet begun. During the migration of the pink salmon in Sakhalin Bay in July, large congregations of the white whale were noted, over 700 off Baidukov Is. and more than 200 near Chkalov Is. The white whale was rarely encountered in these areas in October. According to verified data, the numbers of the Sakhalin—Amur population of the white whale do not exceed 7000—10,000, rather than 15,000—20,000 as believed earlier. The total abundance of the white whale population in the Shantar area according to 1987 data is 3000—5000, and in the northern part of the Okhotsk area roughly 15,000; the boundaries of this population have not been determined yet. According to the latest survey data, the total abundance of all three populations of the white whale is roughly 25,000—30,000.

Grey whales. According to 1987 survey data, 19 grey whales of the Okhotsk—Korean population were spotted in the vicinity of Sakhalin Is. on October 15th.

In June—October 1986, the "Tungus" research-scouting vessel conducted a survey of cetaceans in the coastal waters of the Kurile Isls., Kamchatka and the northern part of the Sea of Okhotsk. It was noted that the greater number of grey whales (54% of all those encountered) was found in the Chukchi Sea during the foraging period. The Koryak coast took second place in the abundance of foraging whales (24.9%), the area from Cape Chaplin to Cape Dezhnev third place (13%), and the Anadyr Gulf fourth place (7.2%). A total of 3030 grey whales was counted in the Bering and Chukchi seas combined; the survey data showed that approximately 5500 grey whales were present in an area of 11,000 square miles. Other cetaceans were also observed during this trip.

Pinnipeds. In 1985, a joint Soviet—American expedition was launched on the "Zakharovo" hunting and fishing vessel to study pinnipeds, among others the Pacific walrus. The crew analyzed the biological characteristics of three groups of walruses (the Eastern-Bering Sea group, the Khatyrka group and the Western—Chukchi group), their distribution, age-sex

composition, reproductive capacity, and natural mortality in the postnatal period.

In March—July 1985, the "Zakharovo" crew also gathered material on various aspects of the biology of the habour seal in the Bering Sea; among other things, age data was obtained on 2033 individuals. It was found that the age structure of the harbour seal populations of the Karaginski and Anadyr gulfs differed significantly. The Karaginski Gulf was noted to have a younger composition of animals from 1 to 3 years of age (69.5%) as compared with the Anadyr Gulf (29.4%). It was also noted that the percentage of sexually immature individuals in the Karaginski Gulf was twice as high as in the Anadyr Gulf. It has been confirmed that the females of the Anadyr population begin to breed at a younger age than those of the Karaginski population.

A direct aerial survey of seals and the walrus was carried out in the Bering Sea in April—May 1987. The abundance of the ringed seal in the Karaginski and Olyutorski gulfs was estimated at 1400, and the abundance in the Andayr Gulf and the central part of the Bering Sea at 75,000. Since the maximum haul-out of the ringed seal onto the ice in the Bering Sea takes place at the end of May—beginning of June, the survey data may have been underestimated, as the survey did not cover the fast ice from the western coast of the Anadyr Gulf to the Bering Strait where approximately 40—50% of the ringed seals live. It is estimated that the total abundance of the ringed seal is 130,000.

Since not more than 60% of the range of the harbour seal in the Bering Sea was surveyed in 1987, the derived abundance of seals (60,000) proved to be too low. Compared with the survey data of 1979, the abundance of the ribbon seal increased to 117,000; the bearded seal numbered 52,000 in April, and about 65,000 in May, but these survey data are also too low. The maximum abundance of the walrus stock on the surveyed ice of the Bering and Chukchi seas was about 208,000 head; these data do not reflect the overall abundance, since the eastern part of the Bering Sea was not surveyed completely.

In order to study the distribution and abundance of the coastal seal rookeries, an aerial survey was conducted in 1986 in the Sea of Okhotsk, on the western coast of the Tatar Strait and on Sakhalin Is. where about

7000 harbour seals, 9 bearded seals and 250 northern sea-lions were encountered, on the western part of the seacoast where 2210 harbour seals and 1100 bearded seals were encountered, and in the northern part of the sea where about 7000 harbour seals and 950 northern sea-lions were recorded. More than 7000 ringed seals, more than 3000 harbour seals and about 1000 beareded seals were recorded during another survey of the coast of Penzhina Bay, and about 2500 harbour seals were recorded on the western coast of Kamchatka. The total abundance of the harbour seal at the coastal rookeries of the Sea of Okhotsk is estimated at 48,000—50,000.

The coast of Sakhalin Is. with its numerous spawning rivers is inhabited by seal species such as the harbour seal which, during salmon migrations, forms congregations at the mouths of the spawning rivers. During August—September 1987, observations were conducted at the mouth of spawning rivers in the southern part of the island to study the behavior of the harbour seal, to determine the number of injured pink salmon in the catches, and to analyze the stomachs of the captured seals.

Data on the abundance of the ice forms of seals in the Karaginski Gulf of the Bering Sea were gathered in 1986—1987. The abundance of the ringed seal in this part of the sea was estimated at 3600 in 1986, and 4900 in 1987 (with a 20% correction for the 6000 animals found in the water). The abundance of the harbour seal on the ice of the bay was estimated at 2200 in 1986, and 9500 in 1987 (with a 13% correction amounting to 10,700 seals); the ribbon seal numbered 4300 in 1987, and the bearded seal 1100 in 1986—1987.

Beginning in 1985, a group of staff workers of Kamchatrybvod systematically observed the coastal walrus rookeries on the Kamchatka Peninsula. Six male walrus rookeries have been recorded so far on Verkhoturov Is., Cape Galinvilan in Korf Bay, Cape Seryi in the Olyutorski Gulf, and in Anastasia and Dezhnev bays; the abundance of these rookeries varies from 5000—6000 animals (Verkhoturov Is.) to several hundred walruses (Anastasia and Dezhnev bays). A number of rookeries that are occasionally visited by walruses have also been noted.

We have past and present data on the walrus rookery of the Russkaya Koshka sand bar, which, after a long interval, began functioning again in

1984, as well as data on the distribution of walruses on the ice and at hauling-out grounds of the Anadyr Gulf, the age and sexual distribution of walruses at the Rudder and Meyechkin rookeries, etc.

As a result of the long-term observations on the distribution and abundance of northern sea-lions on the Commander Isls., five sea-lion rookeries were found, three on Bering Is., one on Ariy Kamen Is., and one on Mednyi Is.; a tendency towards a decrease in abundance has been noted.

The mass of the skeleton and its elements was compared in the harbour seal and the Kuril sea, and a series of other investigations was carried out.

Sea otter. A series of investigations on the sea otters of the Commander and Kurile islands and the Kamchatka Peninsula were carried out in 1986—1987. Based on an analysis of the dynamics of sea-otter abundance on the Kurile Isls., we can assume that the process of replacement of the sea-otter stocks has ended; the abundance of the sea otter today is estimated at about 6000. Data are also available on the composition of the sea otter's diet, and the deterioration of its food supply; we also have the results of morphological analyses of 500 sea-otter skulls from different areas of the Commander Isls., the Kamchatka Peninsula and the Northern Kuriles. The 1986—1987 tagging results for the sea otters of the Commander Isls. have been summed up; it has been concluded that at least 40% of the animals should be tagged in order to ensure a sufficient tag return. The long-term and seasonal dynamics of sea-otter abundance in the Cape Lopatka area (Kamchatka Peninsula) were examined in relation to the hydrometeorological conditions and the effect of certain anthropogenic factors. A significant decrease in the abundance of sea otters has been noted in this area over the past four years, predominantly because of their migration to other parts of the range.

A working seminar on sea otters was held in the USSR (Nakhodka) in August—September 1986, and a regular meeting of the working group on sea mammals was held in the USA (Seattle) in December.

Thus, the investigations of 1986—1987 resulted in scientific data which can serve as the basis for developing scientific recommendations for

the protection and rational utilization of the sea mammal resources of the North Pacific.

STUDY OF CETACEANS

by A.A. Berzin and V.L. Vladimirov (TINRO)

Results of observations on the distribution and abundance of cetaceans, conducted from the "Dobryi" whaler in October—December 1987

Analysis of the observation data from the Pacific Ocean indicates that the abundance of the majority of populations of baleen and humpback whales (in the Bering and Chukchi seas and in the Pacific sector of Antarctica) and grey whales (Korean—Okhotsk population) is gradually increasing. Therefore, we are currently interested in acquiring reliable information about encounters with whales in different regions of the Pacific Ocean, especially in its northern part and in the Far Eastern seas.

Considering that neither Soviet, nor American specialists have been conducting investigations on cetaceans in the vicinity of the Aleutian Isls. and Bristol Bay for more than 20 years, and these waters were one of the principal areas of large-scale pelagic hunting in the Pacific Ocean, it is extremely important to determine the abundance of cetaceans in these regions after the total ban on their utilization ten years ago.

Since American specialists were unable to take part in the expedition, the investigations were carried out by the Soviet side from 23 October to 20 December 1987,

Humpback whales, which abound in the Pacific Ocean and in the Far Eastern seas, were almost completely exterminated, and appeared to have survived only in the inaccessible coastal waters around Alaska and the Hawaiian Isls. However, over the past several years, the humpback whale began to appear in the Bering and Chukchi seas. Not a single humpback whale has been encountered off the Kurile and Commander islands and the coastal waters of Kamchatka over the past two decades.

In the expedition on the "Dobryi" whaler, the first humpback whale, measuring about 15 m in length, was encountered on 25 October in the southern part of the Sea of Okhotsk (Fig. 1), but it was the only one encountered in the eastern regions.

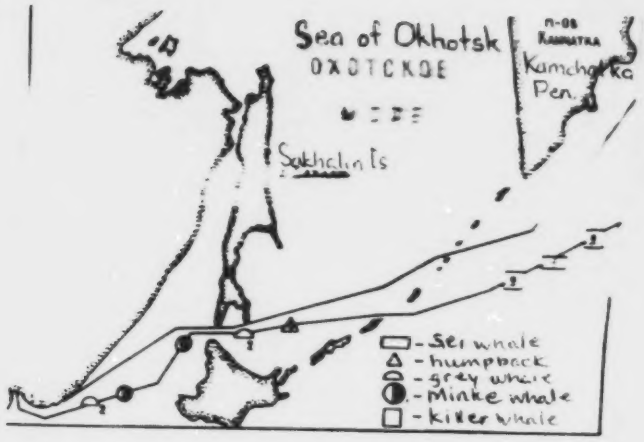

Fig. 1. Sitings of whales at the place of transition to the main study area (23—31 Oct and 12—20 Dec 1987)

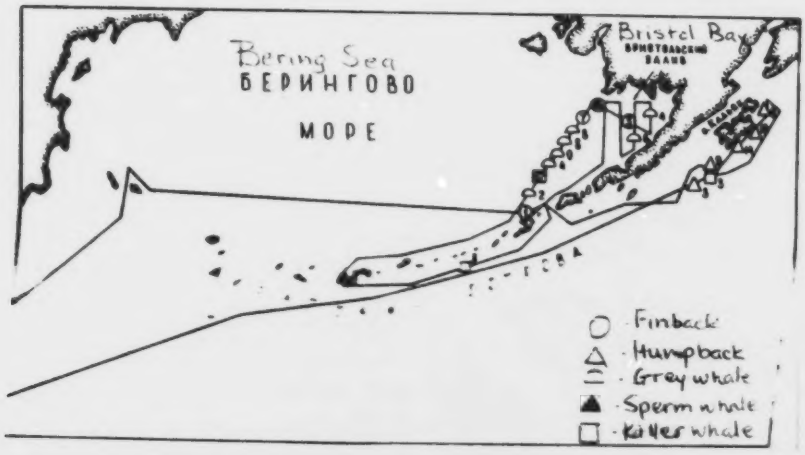

Fig. 2. Distribution of bowhead whales in November—December 1987

On November 3rd, three humpback whales were encountered south of Chirikov Is. (Fig. 2); one measured about 11 m in length, and the others 12—13 m. On November 6th, five 11—15 m whales were encountered 40 miles northeast of Kodiak Is. The whales stayed away from each other, three at a distance of about 300 m, and the others about 600 m away from them.

The largest number of humpback whales (26) was observed on November 8th in the vicinity of Kodiak Is. The whales stayed in three groups; the first consisted of 8 whales from 10 to 14 m in length (three pairs and two single whales were spotted 37 miles south of Kodiak Is.), the second group consisted of 12 whales from 10 to 15 m in length which stayed mostly in pairs not far from each other and 20 miles from shore, and the third group consisted of six 11—12 m whales which stayed in pairs.

On November 9th, nine single humpback whales were spotted at the entrance to Chirikov Strait which separates Chirikov and Tugidan islands.

Forty-four humpback whales were encountered in all during the period of the expedition.

Finback whales in the northern part of the Pacific Ocean were commonly found from the Chukchi Sea to the subtropical latitudes. These whales were the most abundant species of the Balaenopteridae and were of great commercial importance. However, the many years of excessive exploitation of the species, without any allowance for its population structure, affected its abundance; we did not encounter any finback whales in the majority of the areas surveyed.

Bristol Bay was the only area where finback whales were encountered (Fig. 2). The first two finback whales measuring about 18 m in length were spotted on November 21st in the northwestern part of the bay about 30 miles from shore. Four single finback whales 10—11 m in length were encountered on November 22nd within a period of 15 min. Four miles farther, we came across two groups of finback whales, the first group consisting of two 17—18 m whales and a third whale about 10 m long, and the second group consisting of a whale about 15 m long and a second one about 20 m long. Thirty miles farther, we encountered a group consisting of three finback whales 15—16 m in length; two of the whales stayed

together, and the third one some distance away from them. The finback whales spotted on November 21st and 22nd were visible from the shore. For example, in the northwestern part of Bristol Bay, 14 finback whales were encountered over a period of two days, and they all stayed within a comparatively small area.

On November 23rd, we came across three finback whales in a group 60 miles south of the whales encountered on November 21st and 22nd. Two of them measured 16—17 m in length, and the third one about 10 m (apparently a male and a female with their young). On November 26th, we surveyed an area in the western part of Bristol Bay, directly adjacent to the one surveyed on November 21st and 22nd. We encountered seven finback whales, two groups of three whales and a single finback whale. On November 29th, one finback whale was spotted north of Unalashka Is.

Altogether, 25 finback whales were encountered in Bristol Bay.

Grey whales. Up to the end of the 1970s, the majority of specialists believed that the Korean—Okhotsk population of grey whales was in a catastrophic situation, or had even been destroyed, though unofficial sources indicated that several tens of whales were caught in the winter habitats of this population (off the Korean coast). On the other hand, not more than five grey whales had been encountered in the Sea of Okhotsk over a period of several decades, but this information may not be reliable.

In the 1980s, we began to ecounter grey whales (about 20 at the most) in different parts of the Sea of Okhotsk, namely in the vicinity of NE Sakhalin, in the northern part of the Kurile chain of islands, along the western coast of the Kamchatka Peninsula (at the mouth of the Opala R. and in Kambalnaya Bay), and in the northern part of the Sea of Okhotsk (Blokhin et al., 1985; Berzin et al., 1986). Some of the information requires verification, but in any case, we can say that the Korean—Okhotsk population of grey whales not only exists, but is apparently increasing in numbers.

It is difficult to say whether one independent Japanese—Kurile population of grey whales existed, or a certain part of the Korean—Okhotsk population overwintered in the inland sea of Japan; however, these whales were also regarded as depleted. True, individual grey whales have been observed along the entire Kurile chain of islands, and it may be that those

encountered off the N Kuriles and the Kamchatka Peninsula overwinter off the shores of Japan.

We attempted to trace the migration route of the Korean—Okhotsk population of grey whales that spend the summer off the northeastern coast of Sakhalin Is. At the end of October, grey whales are no longer encountered in this area. Neither are they encountered along the probable migration routes farther south. It is not excluded that the grey whales keep farther from shore during their migration, while the aerial surveys were conducted within visible distance of the shore.

This encounter of grey whales about 40 km from shore in the area of S Sakhalin can serve to confirm this assumption. The four grey whales encountered in the vicinity of the Rudnaya Pristan settlement and in La Perouse Strait were also spotted at quite a distance from the shore (Fig. 1).

During our work in the Bering Sea, the first and only groups of grey whales were encountered on November 23rd and 24th in the parts of Bristol Bay farthest from the open sea, two groups of two and four whales in the southeastern part of the bay, and two pairs of whales in the northeastern part (Fig. 2).

Most of the grey whales were encountered outside the bay area, but not far from it, along the route from the northwestern part of the bay to Unalashka Is. On November 26th, a group of 8 whales (3 of them young ones 8—9 m long) travelling southward was spotted 25 miles from the shore. The largest ones were 13—14 m long; the body of one of the adult whales was completely covered with fouling, and had a very light colour. The depth in this area was 27 m. Four hours later, two groups of five and three grey whales were encountered within 10 minutes of each other. On November 27th, 19 grey whales forming eight groups were encountered in four hours. Five of the groups consisted of two whales, and the other three groups each consisted of 3 whales. The whales measured from 11 to 13 m in length. One of the whales was about 7 m long. Therefore, 45 grey whales of the California—Chukchi population were encountered over a period of three days in the eastern part of the Bering Sea (Bristol Bay and the areas adjacent to it).

Other cetaceans. Four Minke whales were encountered in the Sea of Japan on October 24th and 25th. One was spotted on the Olga Bay traverse about 40 miles from the shore. Two Minke whales were then seen 50 miles east of the Rudnaya Pristan settlement. The fourth Minke whale stayed in the western part of the La Perouse Strait (Fig. 1).

The only sei whale was encountered on the Pacific side of Simushir Is. (Fig. 1).

During the expedition, we encountered only one group of male sperm whales in the Amchitka Strait (Aleutian Isls.) on December 2nd. The whales measured less than 15 m in length; they were encountered singly in an area with depths varying from 600 to 1200 m (Fig. 2).

Killer whales were encountered in the Bering Sea and in the Pacific Ocean. On October 28th, five killer whales were spotted on the Pacific side of Simushir Is. (two groups of two whales, and a solitary male). The following day, on October 29th, five killer whales were spotted travelling in a group which included one male (Fig. 2).

On November 9th, a group of three killer whales, including one male, was recorded in the vicinity of the Chirikov Strait. The largest number of killer whales, 67 (Fig. 2), was encountered on November 28th on the traverse of St. Paul Is. (Pribylov Is.) in the Bering Sea. All of them were spotted within 5 minutes. There was only one solitary killer whale among these; the rest of the animals formed ten groups consisting of 4 to 12 whales. On December 4th, a group of three killer whales was recorded in the vicinity of Unalashka Is. A total of 90 killer whales was noted during the expedition.

Dolphins were encountered in groups of ten practically every day in all of the areas surveyed, with the exception of Bristol Bay. Approximately 900 of them were encountered during the expedition.

Conclusion

As a result of the investigations carried out on the "Dobryi" whaler from the end of October to 10 December 1987, the coastal waters of the Aleutian Isls. on both the Pacific and Bering side, Bristol Bay and the Kodiak Is. area were surveyed.

At the place of transition to the principal study area, grey whales were encountered for the first time in many years in the waters off Primorye (Maritime Territory of the Soviet Far East - transl.) and in the La Perouse Strait, which makes it possible to trace the migration route of the Korean—Okhotsk population of whales.

The largest number of whales was encountered in Bristol Bay. The congregations of finback whales encountered in Bristol Bay and the humpback whales encountered in the vicinity of Kodiak Is. were of different age, which indicates that their numbers are increasing. There were practically no whales in the vicinity of the Aleutian Isls. west of Unalashka Is. on the side of either the Bering Sea, or the Pacific Ocean. The exception was a small group of sperm whales encountered in the Amchitka Strait. Not a single Atlantic right whale was encountered in any of the areas surveyed, though Bristol Bay and the waters off the eastern part of the Aleutian Isls. were among its principal habitats. Not a single blue whale was encountered either.

The fact that there are practically no sperm whales in the coastal waters of the Aleutian Isls., blue whales off Kodiak Is. and right whales in Bristol Bay is a cause for deep concern. These species of whales used to form large congregations in these areas in the 1950s—beginning of the 1960s. Naturally, we must assume that, after the excessive exploitation of these species, their numbers in these populations have not been restored, and are currently at a catastrophic level, or possibly non-existent.

On the other hand, we must consider the period in which our observations were conducted, i.e. November—December, when the absence or insignificant number of whales in the northern regions can be attributed to the migration of most of them southward, to the wintering grounds. True, observations during intensive whaling during the 1950s—beginning of the 1960s showed that some of the whales (sometimes quite a large number of them) overwintered in their summer habitats. In any case, it is premature to draw any conclusions regarding the status of these whale populations on the basis of these particular observations, which in principle have provided us with highly interesting material.

It seems that the populations of large whales in the northern part of the Pacific Ocean, which are overexploited to this or that extent, can serve

as models for studying the population dynamics of large mammals of different levels of abundance.

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Results of aerial surveys to study the distribution and abundance of cetaceans in the coastal waters of the Sea of Okhotsk in 1986—1987

by A.A. Berzin, V.L. Vladimirov and N.V. Doroshenko (TINRO)

Aerial surveys to study the distribution and abundance of cetaceans in the Sea of Okhotsk have been conducted on a regular basis since 1979. During this time, the observations have been carried out from a Mi-8 helicopter using methods described by A.A. Berzin and N.V. Doroshenko (1981).

The Sakhalin Gulf, the Amur estuary and the bays of the Shantar area were surveyed in August—October 1986. Investigations were carried on in Penzhina Bay at the beginning of June 1986. Aerial surveys were conducted in July—October 1987, taking in the water area of Sakhalin Bay, the Amur estuary, the Amur R. to Nikolayevsk-on-Amur, and the bays of the Shantar area.

In August 1986/87 and October 1987, observations were conducted in the vicinity of the northeastern coast of Sakhalin Is.

Flights over polynyas, cracks and fractures in the ice in the coastal zone of the Sea of Okhotsk were carried out in November, January and at the beginning of May 1986—1987 to establish the probable wintering grounds of the bowhead whales and white whale. Not one of these species of cetaceans (mainly the white whale) was seen in the study areas, though

we do have sufficiently reliable observation data gathered during the winter period in the Sea of Okhotsk.

Bowhead whales. Since 1979, we have continued to monitor groups of bowhead whales in the southern part of the Shantar area. We have established that there has been no increase in the numbers of these whales in all the years of our observations, though suckling young whales have been noted alongside adult whales and the mating of adults observed during certain years (Berzin et al., 1986). There were about 20 bowhead whales spotted in this area (Akademiya, Ulbansky and Konstantin bays), and if their numbers fluctuated somewhat, it was mainly in the direction of a decrease.

Fig. 1. Distribution of bowhead whales and the white whale in 1987:
1 - bowhead whales, 2 - white whale

In Konstantin Bay in July 1987, we encountered 47 bowhead whales (Fig. 1), and in October about 40 whales which stayed in Ulbansky Bay and were no longer present in Konstantin Bay. Another important fact is that we came across whales (about 3/4 of the total numbers) which were twice as long as the mother (juveniles). Where earlier we had assumed that newborn whales did not survive due to certain factors, we can now say with certainty that the abundance of bowhead whales in the Shantar area should increase with time.

We do not quite comprehend this sudden increase in the abundance of bowhead whales in their traditional areas of distribution. However, this apparently occurred as a result of their migration from the relatively poorly surveyed open parts of the sea.

At the beginning of June 1986, we surveyed Penzhina Gulf with Gizhiga and Penzhina bays. For the first time, we encountered bowhead whales in the vicinity of Gizhiga Bay. Local inhabitants had previously reported seeing up to 10 large whales south of the Chaibukha settlement every spring. Our observations established that this area is inhabited by bowhead whales.

The first whales were spotted on June 6th off Rechnaya Matuga Is. The three animals stayed apart, and about 300 m from the shore. Another whale was spotted off Cape Glinyanyi close to shore. A tight group of seven bowhead whales was recorded that same day in the small Topolovka Bay. The whales stayed close to shore. Another group of six animals was encountered on the Cape Granitnyi traverse (3—4 km from shore); they were solitary animals, but stayed close to each other.

The bowhead whales (17 in all) stayed mainly in the same area throughout the observation period, migrating only slightly. Their behavior indicated that they were foraging actively. Mating was also observed. All of the whales encountered were large, and there were no young ones among them.

We do not know how long the whales stayed in this area, but TURNIF observer S.I. Lagerev reported that no bowhead whales were seen in this area after July 20th, despite thorough aerial observations. Bowhead whales were not seen in any of the other coastal areas of Gizhiga and Penzhina bays either.

It is still difficult to tell whether the bowhead whales of the Shantar area and Gizhiga Bay form two populations or two groups similar to a deme of the same population, though their ranges are clearly discontinuous, not only at the present time after obvious overexploitation of the species, but on the basis of previous data as well.

White whale. In 1986, an aerial survey of the white whale in Sakhalin Bay (Fig. 3) was conducted over a period of several days in August and October; the data obtained are clearly insufficient for judging the

abundance of the white whale in the gulf during this particular year. The observations coincided with the end of the migration of summer chum, and the migration of autumn chum had not yet begun; this is probably why the white whale did not congregate in the vicinity of Baidukov Is., Chkalov Is. and Zotov Bank, but instead dispersed over the large area of Sakhalin Gulf.

Fig. 2. Distribution of bowhead whales and the white whale in 1986:
1 - bowhead whales, 2 - white whale

Fig. 3. Distribution of the white whale and grey whales in 1986—1987:
1 - grey whales, 2 - white whale,
3 - boundary of white whale population

During the mass migration of autumn chum, the abundance of the white whale in the southern part of Sakhalin Bay increased considerably; this was noted by S.I. Lagerev who, at the beginning of September 1986, recorded about 2000 white whales in this area. Large congregations of the white whale in Sakhalin Bay were noted during the migration of Pacific salmon. For example, more than 700 white whales were counted in the bay from Baidukov Is. to Zotov Bank (a distance of 18 km) on 17 July 1987. Over 200 white whales were noted off Chkalov Is. on July 22nd.

In October 1987, as in the previous year, the white whale was rarely encountered in Sakhalin Bay. At the same time, up to ten whales were observed off Baidukov Is., and 10—15 near Zotov Bay.

Over the past years, we have been going by Melnikov's numbers of the Sakhalin—Amur white whale population, i.e. 15,000—20,000 head (Melnikov, 1984). However, detailed aerial surveys of recent years and our

own extensive survey data (gathered among lighthouse attendants, whale hunters, fish inspectors, etc.) from different areas known to be inhabited by the white whale have clearly shown that the range of the Sakhalin—Amur population of the white whale is smaller (due to a significant reduction of its southern part), while its density in the northern part of the range differs from place to place. We have estimated the Sakhalin-Amur population at not more than 7000—10,000 animals, and these numbers probably require further verification.

The previous high abundance of the white whale was undoubtedly obtained by extrapolation of individual observations of large congregations (up to 1000 animals or more) to the entire vast range of this population.

In the Shantar area (Fig. 1), the abundance of the white whale in 1987 was the highest over all the previous years of observations. In July, 33 white whales were recorded in the uppermost part of Nikolai Bay. In Ulbansky Bay, the white whale kept mainly to the area of the Betty sand bar, where about 70 of them were noted, but this is only one-half of the number of white whales recorded in July 1984, when more than 140 were spotted in the bay. The highest abundance of the white whale was noted in the southern part of Tugursky Bay where more than 250 animals were encountered in July. The total abundance of the Shantar population of the white whale is roughly 3000—5000.

Observations on the white whale in the Penzhina Gulf (Fig. 2) were conducted at the beginning of June 1986. On June 6th, about 60 white whales, including young animals, were noted in the uppermost part of Malaya Gizhiga Bay (central part). The whales stayed mainly in groups of 3—4, but one group consisted of 10 animals. Solitary white whales were rarely encountered. About 90 white whales, mostly solitary ones, were recorded on June 9th, also in the uppermost part of Malaya Gizhiga Bay. Approximately the same number of white whales was observed on June 13th enroute from the Chaibukha settlement to Cape Yekaterina. The animals were foraging, and were dispersed over a large area. That same day, seven white whales were noted in the vicinity of the Evensk settlement.

According to a hunter by the name of A.P. Gubarkov, the white whale forms large congregations in Gizhiga Bay from the middle of July, during

the mass migration of Pacific salmon. This was confirmed by S.I. Lagerev who observed 2500—3000 white whales in the northern part of Gizhiga Bay.

Penzhina Bay was surveyed on 7 June 1986. From Cape Povorotnyi to Cape Naklonnyi, we encountered about 40 white whales travelling northeastward along the coast at a distance of up to 500 m away from it. About 30 of these animals formed a close group of animals of different ages. In the vicinity of Cape Naklonnyi (mouth of the Kychuveveyem R.), several groups of white whales totalling over 30 head were seen travelling about 100 m from shore in the northeastern direction.

Approximately 30 km from Cape Naklonnyi, 17 white whales were recorded that same day. About 50 white whales were noted 20 km from Cape Naklonnyi at the mouth of the Talnaveyem R. The whales kept to the coastal shallows without going anywhere. This congregation apparently consisted mainly of females and their young, since groups of two predominated, one whale being the mother and the other the baby; suckling was also observed. One group consisted of four baby whales.

A congregation of about 30 white whales was encountered in Lakhtachy Bay (10 km northeast of the Talnaveyem R.). The animals kept apart, and travelled northeastward. The following day, no white whales were spotted in this area. A group of six white whales kept to Melkovodnaya Bay. About 25 white whales were noted on the stretch from the Yelistratov Peninsula to Cape Pupyr. Each animals foraged on its own 3—5 km from shore. This type of behavior was also observed in 15 white whales encountered enroute from Cape Pupyr to Cape Obryvistyi. Four white whales kept to the strait separating Cape Obryvistyi and Dobrzhansky Is.

On 8 June 1986, four white whales were spotted in the uppermost part of Penzhina Bay near Anapel Is. Fourteen white whales were counted in the Penzhina R. from its mouth to the Manila settlement. Further observations were carried out from the mouth of the Penzhina R. southward along the western coast of the Kamchatka Peninsula to the northern part of Rekinnikskaya Bay, but no congregations of white whales were noted. On the stretch from Cape Krainiy to Cape Valizhgen, only

seven white whales were noted. One white whale kept to Mametchinsky Bay, and one whale to the northern part of Rekinnikskaya Bay.

Based on the latest material available to us, the abundance of the white whale population in the northern part of the Sea of Okhotsk can be estimated at roughly 15,000. We have not yet determined the boundaries of this population.

The total abundance of the three white whale populations in the Sea of Okhotsk is roughly 25,000—30,000 (our data).

Grey whales. Since 1984, we have been monitoring a group of grey whales of the Okhotsk—Korean population off the northeastern coast of Sakhalin Is. (in the vicinity of Piltun Bay) (Fig. 3). Up to 1986, their numbers varied from 18 to 20 animals. On 11 August 1986, 24 whales were counted in the same area. We encountered only 9 whales here in August 1987, and 19 whales on October 15th.

The grey whales leave this area at the end of October, possibly at the beginning of December, as ice begins to form and set. For example, we recorded only four grey whales at the entrance to Piltun Bay on 25 Octiber 1986. Our attempts to find grey whales at a later date along the eastern coast of Sakhalin Is. were unsuccessful.

It can be said that the previous summer range in the Sea of Okhotsk is being slowly filled by grey whales. According to survey data, grey whales (up to 10 animals) were encountered in Kambalnaya Bay (southern part of the Kamchatka Peninsula), five whales were seen in the vicinity of Cape Crillon in January, and one grey whale is constantly seen in Shelting Bay (west of Magadan) in October.

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Results of the expedition of the "Tungus" research-scouting vessel in the coastal waters of the Far Eastern seas in June—October 1986

by S.A. Blokhin (TINRO)

Researchers have lately shown a special interest in the grey whale. Due to their initial low numbers at the end of the 19th and beginning of the 20th centuries, the Korean—Okhotsk population of these animals has been almost completely eliminated; it numbers only several tens of animals at the present time. The Californian—Chukchi population of grey whales, which was placed under the protection of the International Whaling Commission (IWC), found itself in a better situation which enabled it to increase its numbers. Today, the animals of this population are the most abundant of all the large cetaceans inhabiting the northern part of the Pacific Ocean. The keen interest in these whales is also due to the fact that they are the only cetaceans that are being utilized for the needs of the local population of Chukotka.

The main purpose of the expedition carried out on the "Tungus" research-scouting vessel from 13 June to 25 October 1986 was to determine the present abundance and distribution of grey whales off the Far Eastern coast. At the same time, other species of whales were surveyed not only in the main study areas, but also in the coastal waters of the Kurile Isls., Kamchatka and in the northern part of the Sea of Okhotsk.

Material and method

Observations at sea were conducted when the visibility was at least 5—7 miles and the turbulence not more than 3. The vessel was allowed to drift during the dark hours. A line of scouting stations set 12—15 miles apart was established only in the areas where grey whales were expected to be found in the Bering Sea, north of 61° N lat. In the Chukchi Sea, the stations were at first executed every 30 miles; after whales were detected south of 68°30' N lat, they were executed every 15 miles. When grey whales were encountered, the route of the vessel along the line of stations was not altered as a rule, and the animals were counted by their spouts,

silhouettes and caudal fins. Observations showed that the spouting of the grey whale on a calm day can be seen at a distance of 6—8 miles from the top bridge of the vessel (7 m above sea level).

The course of the vessel and the areas in which the stations were executed are shown in Figs. 1 and 2. The dotted line in the diagrams marks the approximate area surveyed.

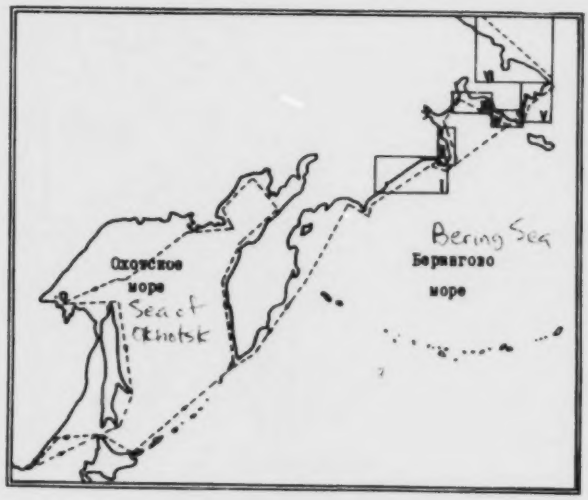

Fig. 1. Course and survey areas of the "Tungus" research-scouting vessel from 14 June to 25 October 1986

The areas in which grey whales were spotted (Fig. 3) were divided into equal squares of 25 sq. miles (5 x 5 miles). To calculate the density of whales in this or that area, the number of animals counted was divided by the sum of the square areas in which they were encountered. To determine the total number of grey whales in this or that area, we used correction factors, the value of which was selected in relation to other factors. For example, if five whales were recorded close to the vessel (1—2 miles) within a 5-mile stretch under top visibility conditions, it was assumed that the given square was occupied by not more than 5 whales. However, if the whales were noted more than 3 miles from the vessel and an accurate count posed a problem, the number of animals observed was doubled. Under poor meteorological conditions, the number of animals

seen in the distance was tripled. Despite the fact that these coefficients were proved in practice, they still cannot be regarded as absolutely accurate in each specific case. In our opinion, however, the use of these coefficients enables us to estimate more objectively the abundance of grey whales in the given water area.

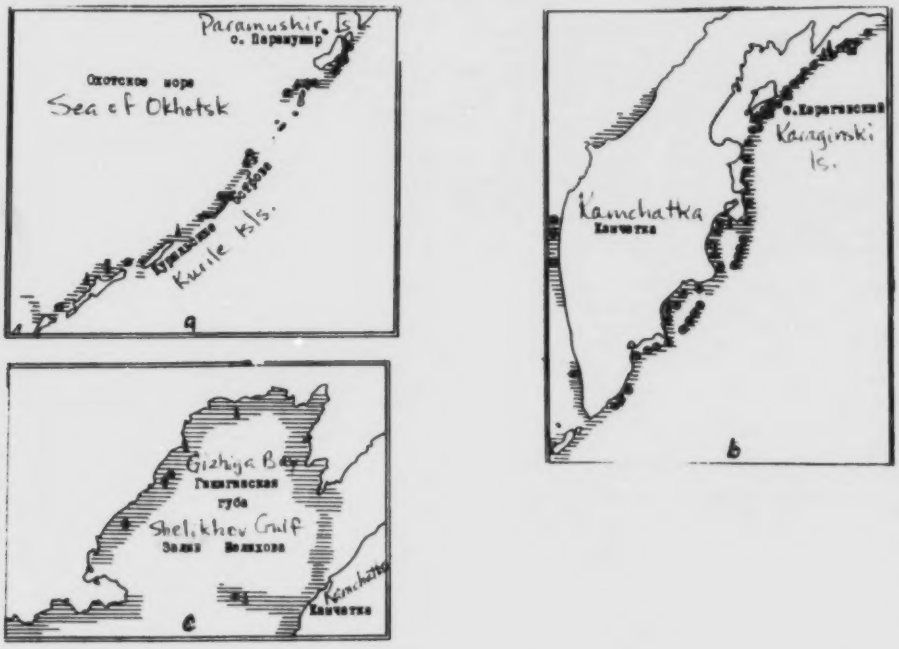

Fig. 2. Survey area and points of encounter of cetaceans

a - coast of Kurile Isls.; b - Kamchatka Peninsula; c - northern part of the Sea of Okhotsk; ▮ - sperm whale; ▬ - Baird's beaked whale; ▲ - killer whale; ◓ - Dall porpoise; ◆ - Minke whale; ● - right whale; ■ - finback whale

Results of investigations

Sea observations began immediately following the departure of the vessel from Vladivostok. Only dolphins were encountered in the Sea of Japan on June 14—17th (striped dolphin and Dall porpoise) (see Summary).

In the waters of the Kurile Isls., observations were conducted from June 19th to June 23rd, and the highest abundance of cetaceans was noted off the Northern Kuriles. The Dall porpoise was predominant among the animals encountered (see Fig. 2 and Summary).

Two Atlantic right whales were encountered 10—11 miles from the eastern coast of Paramushir Is. over depths of 90—100 m; one of the

animals was 13—14 m long, and the other 10—11 m. They stayed in a pair, and did not show any anxiety over the presence of a vessel nearby.

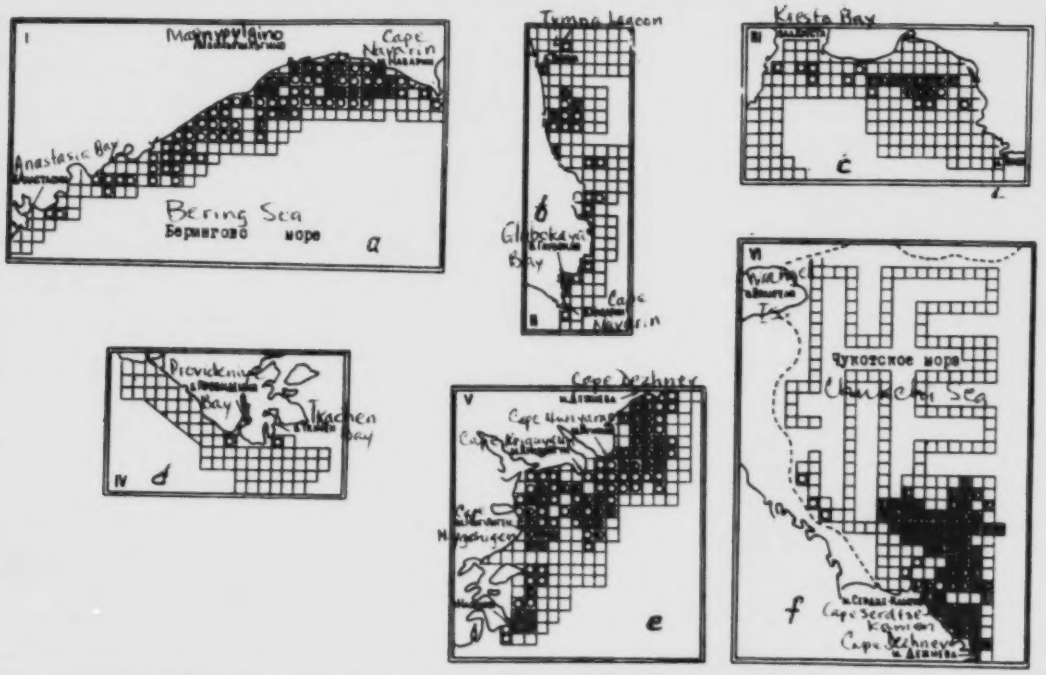

Fig. 3. Distribution of grey whales: a - along the Koryak coast (area I); b - in the Anadyr Gulf from Cape Navarin to the Tymna Lagoon (area II); c - in the Anadyr Gulf from Kresta Bay to Cape Chaplin [obviously, some text has been omitted at this point - transl.) to Cape Dezhnev (area V); f - Chukchi Sea (area VI)

○ - up to 5 animals; ◐ - 6-15; ● - 20 and more; □ - none encountered

Off the eastern coast of Kamchatka, the Dall porpoise was the most abundant, numbering 340 in June, and 310 in September—October; this amounts to 78.0 and 99.7% of the total number of cetaceans encountered in this area.

The majority of the Dall porpoises were encountered in groups of 5 to 10—12, and they were usually spotted at a distance of not more than 2 miles from the vessel. The reaction of the cetaceans to the passing vessel varied; some of the animals attempted to catch up and accompany it, while others showed no interest at all.

Off the southeastern tip of Karaginski Is., we encountered 40—50 killer whales which, in groups of 2 to 5—6, kept within an area of about 25 sq.

miles. A large number of young whales 3—4 m in length were among them. In the centre of this large group of killer whales, we saw several Minke whales which displayed no apparent anxiety over the presence of the killer whales. All the animals were travelling in the direction of the island, and did not react to the close presence of our vessel.

We surveyed the waters off the western coast of the Kamchatka Peninsula in October, and found fewer cetaceans there than in the waters off the eastern coast (Fig. 2, b). Our encounter with three right whales (species not determined) was the most interesting in this area.

Observations were carried on from October 7th to12th in Shelekhov Gulf (Fig. 2, c). Compared with the other areas, the weather conditions here were the best. Perfectly calm and sunny weather enabled us to conduct observations from the mast top of the vessel, and survey the surrounding area for a distance of 10—12 miles; however, despite this, very few whales were encountered in this area (see Summary).

Since most of our attention was devoted to studying the distribution and abundance of grey whales, the results of these investigations will be examined in greater detail for each of the given areas.

Area I - from Anastasia Bay to Cape Navarin (Fig. 3, a). In this area, the whales were counted three times (see table). We spotted the very first grey whales, a group of six, on July 2nd north of Anastasia Bay at 61°23' N lat. and 173°21' E long.

The largest number of grey whales, 793, was recorded in this area in July. A somewhat smaller expanse was surveyed in this area in August, and 450 grey whales were recorded. In September, the number of whales in this area decreased significantly to 182 (276). All of the grey whales encountered were spotted over depths not greater than 50 m. In the coastal waters in the vicinity of Mainopylgino, at the mouths of certain rivers and near lagoons, the animals kept to the shallow waters several metres from the shore. Only once did we encounter a group of whales (about 60) in waters 55—58 m deep.

Table. Survey of grey whales in the coastal waters of the Bering and Chukchi seas in July—September 1986

Area	Boundary	Date of survey	No. of whales counted	Area of water expanse in which whales were encountered, sq. mi
I	From Anastasia	2,7,30 July	793	1725
	Bay to Cape	1-4 Aug	450	1125
	Narvin	19-23 Sept	182	750
II	From Cape	9-12 July	124	475
	Narvin to	19 Sept	18	225
	Tymna Lagoon			
III	From Kresta	13-15 July	113	400
	Gulf to Cape	13-17 Sept	38	275
	Achchen			
IV	From Cape	16, 18 July	-	-
	Achchen to	6 Aug	7	50
	Tkachen Bay			
V	From Cape	18-21 July	230	850
	Chaplin to Cape	1-10 Sept	276	950
	Kriguygun			
V	From Cape	23-24 July;	175	675
	Nuiyamo to	1-2 Sept	161	700
	Cape Dezhnev			
VI	Chukchi Sea	8-30 Aug	1450	6275
TOTAL			2938	10,775

The distribution of grey whales in the area was irregular; we noted no clear tendency in their preference for this or that part of the area. In August, for example, we noted a large number of whales in the places where none or very few were encountered in July and September. The whales stayed in groups of 4—5 to 50—60 animals and foraged actively; only in certain places did we encounter solitary whales travelling in a definite direction without prolonged diving. Females with sucklings (15—20 pairs) were noted in some of the near-shore parts of this area.

Large (13—14 m) and medium-sized (11—12 m) animals prevailed in this area.

Area II - from Cape Navarin to the Tymna Lagoon (Fig. 3, b). One hundred and twenty-four grey whales were counted in July, and only 18 in September.

This area was characterized by the presence of solitary whales and groups of 2—3 whales which, judging by their behavior, were not foraging. Only in the Tymna Lagoon did we note 30—40 actively feeding animals. Of great interest was the discovery of a large number of grey whales close to the shore in the small Gabriel Bay in July. We counted 34 of them, the majority being females with sucklings (approximately 12 pairs). We found no whales in this bay when we surveyed it again in September. Another nine pairs of mother and baby were counted in other places along the coast in this area.

Large whales were not observed in this area.

Area III - from Kresta Gulf to Cape Achchen (Fig. 3, c). One hundred and thirteen grey whales were counted in this area in July, and only 38 in September. Both solitary whales and groups of 2 to 20 animals were observed. Nearly all of the whales kept to the central part of the area in July, whereas they spread out more in September and could not be found in those parts of the area where they had abounded the month before. All of the whales encountered were foraging actively and stayed in one place at the time of the observations. The majority of the animals of this area were of average size.

Area IV - from Cape Achchen to Tkachen Bay (Fig. 3, d). Whales were not encountered in this area in July. Only in August did we encounter six whales at the entrance to Provideniya Bay; judging by their behavior, they were foraging.

Area V - from Cape Chaplin to Cape Dezhnev (Fig. 3, e). We have divided this area into two subareas, a southern one extending from Cape Chaplin to Cape Kriguygun, and a northern one from Cape Nunyamo to Cape Dezhnev.

In the southern subarea, 230 grey whales were counted in July, and 276 in September. There were fewer grey whales in the northern subarea, 175 in July and 161 in September. As we can see from these data, the abundance of whales in this area from July to September remained quite steady. Approximately 700 grey whales foraged within this area from July

to September. As in the previous areas, the distribution of grey whales in the given area was also irregular. The majority of the animals stayed in scattered groups of 3—5 to 30—50. Only in September did the whales form dense congregations east of capes Nygchigen and Chaplin.

The majority of the whales in this area foraged actively; we noted only two whales swimming northward close to Cape Dezhnev at the beginning of August. Whales ranging from 9 to 13—14 m in length were present in this area.

Area VI - Chukchi Sea (Fig. 3, f). In the Chukchi Sea, observations were conducted only in August. Grey whales were spotted in the southeastern part of the area at 68°30' N lat, 173°30' W long (from the west) and 169°00' W long (from the east). One thousand four hundred and fifty grey whales were counted on an area of 6275 sq. miles.

The highest concentration of grey whales was noted in the southern part of the area, where about 250 whales were simultaneously present in an area of approximately 75 sq. miles north of the Bering Strait and the Uelen settlement. On the whole, however, the grey whales of the Chukchi Sea were distributed more uniformly than in the other areas. All of the animals foraged actively, and stayed practically in one place; only at the end of August were some whales seen swimming slowly towards the Bering Strait and diving frequently 10—15 miles from the shore southeast of Cape Serdtse-Kamen.

Whales of different sizes, from 9 to 13—14 m in length, were seen foraging in the northern part of the area, whereas small 9—11-metre whales prevailed in the southern part.

Six whales were recorded west of the principal area of their congregation in the Chukchi Sea. These were large solitary whales and pairs of whales, which were travelling northwestward along the edge of floating ice and diving periodically.

Discussion of results

We were somewhat surprised to see a relatively large number of grey whales in the Chukchi Sea where 54.7% of all the whales recorded by us off the Far Eastern coast were foraging in August.

Second place in the abundance of foraging whales goes to the area located off the Koryak coast (area I) (Fig. 3, a), where the maximum number of animals was recorded in July—August. Third place goes to the area extending from Cape Chaplin to Cape Dezhnev (area V) where 13.0% of all the whales was encountered. In the Anadyr Gulf with its two small foraging areas, about 400 whales were encountered in July—August (Fig. 3, b, c).

During the surveys in the Bering and Chukchi seas, we counted 3030 grey whales in all. The use of correction factors for each separate area has brought us to the conclusion that approximately 5500 grey whales were present within an area of about 11,000 sq. miles in July—August 1986.

The ease with which grey whales can be counted because of their ecological characteristics (brief periods of submersion, prolonged presence in a certain area) allows us, in our opinion, to record practically all the animals in a study area with a few simple procedures. Therefore, we dare to assume that our estimation of the number of grey whales foraging off the Far Eastern coast during the summer—autumn period of 1986 comes fairly close to the actual number (Fig. 4).

Fig. 4. Principal foraging grounds (darkened) of the Californian—Chukchi population of grey whales off the Far Eastern coast

The majority of the grey whales in the study areas stayed in groups of 2—3 to 50—60 animals and foraged actively. An indication of the latter was the frequent diving of the animals, followed by the projection of the tail. The respiratory rhythm of the whales in different areas was about the same, i.e submersion lasted 3—4 min on the average, and the respiratory pause 60—90 seconds; during this period, the animal spouted 6 to 9 times. Only some of the whales travelled in a particular direction with frequent short dives lasting 1—2 min.

The largest grey whales were observed in the 40—50 m waters off the Koryak coast (area I), as well as between Cape Nunyamo and Cape Dezhnev (area V). Small whales were encountered in all the areas, and, as a rule, kept closer to the shore. This tendency of size distribution has to do with the way in which these animals obtain their food (it is easier for young whales to forage in shallow waters).

As we know, the suckling period lasts about 7 months in the grey whale (Rice, Wolman, 1971). Therefore, we expected to encounter a large number of females and their young off the Far Eastern coast in July. However, we spotted only 40 mother and baby pairs during this month. We have no explanation for this, but it is possible that some of the sucklings may have been overlooked because of their small spouts. At the same time, a large number of young whales about 9 m long was observed in the southern part of the Chukchi Sea in the second half of August; they stayed in dense congregations without adult whales. This indicates that most of the sucklings of the grey whale change to independent feeding, leave their mothers, and form their own groups at this time.

The whale observations conducted over a long period of time at different times of the day have shown that these animals submerge practically nonstop. During our investigations, we did not observe any animals that remained inactive for long on the surface of the water. These facts confirm that grey whales forage actively off the Far Eastern coast during the summer—autumn period.

Preliminary processing of the hydrobiological data gathered during the expedition[1] has shown that the grey whale's largest supply of

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[1]Analysis of the benthos during the expedition was carried out by TINRO worker V.A. Pavlyuchkov, to whom the author expresses his gratitude.

nutritious benthos (amphipods) is found in the Chukchi Sea. These data clearly illustrate the dependence of the species' distribution on the food supply in this or that area. At the same time, we should note that in some areas, whales were not always encountered in the places of maximum concentration of food. A large number of whales was often observed in places with the lowest density of benthos. Furthermore, a second survey of some of the areas showed that there were no whales in the places where they had once been abundant, and vice versa. This peculiarity of distribution of grey whales may indicate that the animals feed as if they were grazing, passing from one "pasture" to another as they eat up a certain amount of the food.

As to the supply of benthos, the waters adjacent to the Far Eastern coast are the most favourable for the foraging of grey whales (Neiman, 1963; Berzin, Rovnin, 1966). Therefore, on the basis of the material available to us, we can assume that a large part of the Californian—Chukchi population of grey whales spends the summer—autumn period in the parts of the Bering and Chukchi seas surveyed by us. This, in turn, raises the question of whose data are more accurate, ours or the Americans'. For now, we are refraining from any definite conclusions, for we believe that additonal material is required.

When discussing the distribution of grey whales in the coastal waters of the Bering and Chukchi seas, we should consider the periods spent at the foraging grounds. In 1986, for example, a group of 20—30 grey whales was noted by fishermen off Cape Navarin on May 2nd (V.A. Gaponova, verbal communication). Hunters of the Chukchi settlement of Lorino see grey whales in the middle of May every year in the pools of open water in ice east of Mechigmen Bay. In 1984, we spotted the first grey whales off Cape Chaplin on May 15th (Blokhin, 1986), while the local inhabitants claim to have seen them in the same area on May 9th.

The above data indicate that grey whales appear off the coast of the Far East from the beginning of May, when the coastal waters are partially freed of ice. The ice conditions apparently determine the time of departure of the whales from the foraging grounds. For example, on 15 November 1984, we observed from the "Zvezdnyi" whaler about 20 grey whales feeding in the pools of open water in young ice southeast of Mechigmen

Bay. Judging by the behavior of the animals, they were in no hurry to leave this area where the first bowhead whales were already beginning to appear. On 23 November 1984, under conditions of limited visibility, we saw four grey whales as our whaler passed along the Koryak coast; in 1987, grey whales were hunted at the end of November off the southeastern end of the Chukchi Peninsula. These data lead to the conclusion that grey whales perhaps remain in the coastal waters of the Far East up to December, and leave this area with the onset of the ice.

Thus, the grey whales of the Californian—Chukchi population stay in the foraging areas for 7 months, from May to November. We should note, however, that this is not characteristic of all the animals, but only of those that do not have to migrate such long distances to the warm waters of North America.

The investigations conducted during the expedition provided additional information on the mixing of the Korean—Okhotsk and Californian—Chukchi populations. For example, during the detailed observations carried out along the eastern coast of the Kamchatka Peninsula and in the coastal waters from Cape Olyutorski to Anastasia Bay, grey whales were not encountered. This can serve as confirmation that grey whales find their way from the Bering Sea into the area of the Korean—Okhotsk population.

Summary

During our expedition in the coastal waters of the Far Eastern seas, we recorded 12 species of cetaceans, among which the grey whales of the Californian—Chukchi population were the most abundant. The scarcity of the other species of large whales in areas surveyed does not allow us to judge the dynamics of their abundance in the given area after the introduction of the ban on whale hunting.

As a result of our investigations, we now have more information about the boundaries of the range of the Dall porpoise

The data obtained during the expedition allowed us to determine the boundaries of the principal foraging grounds of the grey whale off the Far Eastern coast, where there were about 3000 animals in July—August 1986.

The southern boundary of distribution of the grey whale extended along 61°20' N lat, and the northern one extended along 68°30' N lat in the central part of the Chukchi Sea.

Despite the large volume of material collected during the expedition, these investigations did not provide the answers to certain questions regarding the ecology of the grey whale.

In connection with this, we consider it necessary to conduct additional investigations throughout the summer—autumn range of the grey whale in the Bering and Chukchi seas simultaneously.

The following cetaceans (in addition to the grey whale) were encountered during the expedition:

1. Humpback whale	24
2. Finback whale	18
3. Sei whale	3
4. Right whale	5
5. Minke whale	43
6. Sperm whale	5
7. Baird's beaked whale	32
8. Killer whale	136
9. Dall porpoise	317
10. Striped dolphin	13
11. Dolphin (unidentified species)	33

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STUDY OF PINNIPEDS

Material on the biology of the harbour seal of the Bering Sea

by A.M. Trukhin (TINRO)

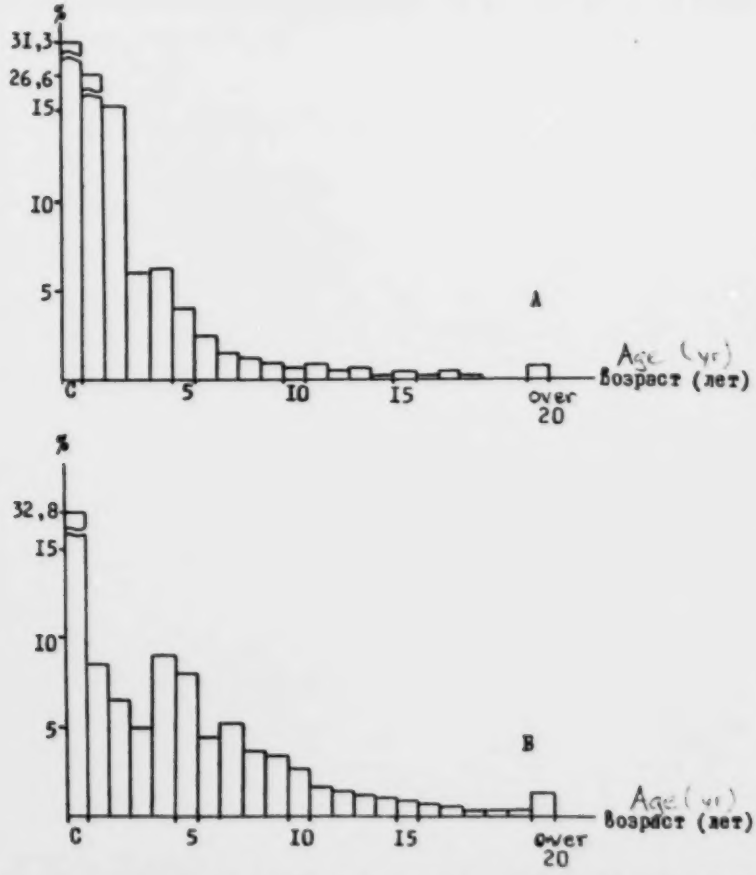
In March—July 1985, we conducted a survey on the "Zakharovo" hunting and fishing vessel to study the population structure of the harbour seal in the Bering Sea. A total 2033 harbour seals of both sexes were studied to determine the age and sex composition (1218 seals from the Anadyr Gulf and 815 seals from the Karaginski Gulf.

The age of the animals was determined by counting the annual layers of cement and dentine in a section of the tusk of the lower jaw (Tikhomirov, Klevezal, 1964; the physiological condition of the females was determined from the macrostructure of the ovaries and horns of the uterus.

On the basis of the phenetic and craniologic characteristics combined with data on the helminthofauna of the harbour seal, we established two independent populations in the western part of the Bering Sea, the Karaginski and Anadyr populations (Goltsev et al., 1979). In connection with this, we shall examine the data on the age structure and physiological condition of the females for each population separately, first converting them to a form convenient for comparison.

We have established that the age structure of the harbour seal populations of the Karaginski and Anadyr gulfs has a number of clearly defined differences. On the whole, the age composition of the harbour seal catch in the Karaginski Gulf was found to be younger than in the Anadyr Gulf (see graph below). Whereas the underyearlings in both gulfs comprised 31.3% and 32.8% of the total number of harvested seals respectively, the 1—3-year-old animals constituted 69.5% of the number harvested (without the underyearlings) in the Karaginski Gulf, and only 29.4% in the Anadyr Gulf. Underyearlings clearly prevail in the catches from different areas, which is due to the fact that the young are less cautious than the older animals and, therefore, they are more easily caught. The average age of the harbour seals in the catch from the Karaginski Gulf (including the underyearlings) was 2.33 years (2.08 in

males and 2.56 in females), and the average age in the catch from the Anadyr Gulf was 4.27 years (4.97 and 3.78 respectively). The percentage of animals over 20 years of age in these populations was insignificant, 0.9% and 1.3% for the Karaginski and Anadyr gulfs respectively.



Age structure of the harbour seal populations (C—underyearlings) of the Karaginski Gulf (A; n=815) and Anadyr Gulf (B; n=1218) of the Bering Sea

In the Karaginski Gulf, females prevailed slightly in the catch of harbour seals, constituting 51.8% of the catch. In the Anadyr Gulf, males prevailed, constituting 54.2% of the catch. As we can see from table 1, the prevalance of females in the catch from the Karaginski Gulf was due to animals of older age groups, in the same way as the prevalence of males in the catch of harbour seals from the Anadyr Gulf. The table also shows that there was no significant predominance of either sex in the younger age

groups of sexually immature animals up to the age of 3 years inclusively. These differences become most apparent with age, the greatest difference in sex ratio being noted in the group of animals ten years of age and older, in which, in the Karaginski Gulf, there are twice as many females as there are males. A similar age—sex composition of the harbour seal was noted here in the past as well (Razlivalov, Bukhtiyarov, 1982; Sadovov, 1986), but it differed somewhat from the composition established on the basis of the 1982 hunting survey (Trukhin, 1987) in which underyearlings constituted nearly 80% of the seals harvested in the Karaginski Gulf.

Table 1. Age—sex structure of the harbour seal populations of the Bering Sea in 1985

Age (yr)	Population					
	Karaginski			Anadyr		
	n	♂♂	♀♀	n	♂♂	♀♀
Underyearlings	255	49.8	50.2	399	47.1	52.9
1-3	388	50.8	49.2	241	53.5	46.5
4-9	136	41.4	58.6	415	58.1	41.9
10 and older	36	33.3	66.7	163	62.2	37.4
Total	815	48.1	51.9	1218	54.2	45.8

A quarter of a century ago, the sexual maturation of the Far Eastern harbour seal was investigated quite thoroughly by E.A. Tikhomirov (1966). Unfortunately, the author gives the periods of onset of sexual maturity for the Sea of Okhotsk and the Bering Sea harbour seal together, in a single table, with an indication that 10% of the females reach sexual maturity at the age of 3 years, 93% at the age of 4 years, and 94% at the age of 5 years. All the females reach sexual maturity at the age of 6 years.

To determine the physiological condition of the female seals, we examined the reproductive organs of 282 females from the Karaginski Gulf and 339 females from the Anadyr Gulf. The uteri and ovaries of underyearlings were not examined, and the females of this age group are not taken into account in this study.

In our comparative analysis of the physiological condition of the females of two populations, we found that the percentage of sexually immature individuals in the Karaginski Gulf was more than twice that of the Anadyr Gulf (table 2). Consequently, the percentage of females that

give birth in the Karaginski population is quite low. This can be attributed to the prevalence of sexually immature animals of young age groups in the harbour seal catch from the Karaginski Gulf. As we can see from table 2, the females of the Anadyr population begin to breed at an earlier age in comparison with the females of the Karaginski population. For instance, only 15.8% of the 4-year-old females in the Anadyr Gulf were sexually immature, whereas 53.6% of the females in the Karaginski Gulf were sexually immature at this age. At the age of 5 years, 64.9% of the females bear pups in the Anadyr population, and only 9.5% give birth in the Karaginski population. The average age at which the females ovulate for the first time is 4.7 yeats in the Karaginski Gulf, and 4.3 years in the Anadyr Gulf.

Sterility is insignificant in both populations, amounting to 3% in the Karaginski Gulf and less than 2% in the Anadyr Gulf. We must heed any increase in the sterility of the females of either population of harbour seals. The females that fail to bear pups during a particular year may avoid hauling out at breeding and moulting grounds where the seals form more or less dense rookeries which serve as the basis for the seal trade; instead, they isolate themselves during this period. This will result in an irregular catch, and the commercial catches will include only a few of these females.

Judging by the fact that approximately 60% of the sexually mature females harvested during the third 10—day period of April already had a fully formed yellow body of ovulation, one can assume that the mating of the Bering Sea harbour seals in 1985 began at the end of the first ten day or beginning of the second ten days of April. On the basis of the structure of the yellow bodies of ovulation examined in the ovaries during different hunting periods, we can say that mating ended during the third 10-day period of May or the first ten days of June. Of the 203 females that had borne pups before, 44 (21.7%) had a yellow body of ovulation in the same ovary that contained the white body of the last pregnancy.

Proceeding from the data on the physiological condition of the females of two populations, it is apparent that the Karaginski population of the harbour seal currently lives in more favourable conditions; the rate of female maturation in this population is slower than in the Anadyr

population, and the average age of its animals is younger than in the Anadyr population of harbour seals.

Our material on the physiological condition of the females of the harbour seal points to the presence of two independent populations with different reproduction rates in the western part of the Bering Sea.

Table 2. Physiological condition of female harbour seals

Age	Sexually immature		Sexually mature						Total
			Ovulating for the first time		Ovulating after giving birth		Sterile		
	No.	%	No.	%	No.	%	No.	%	
				Karaginsky Gulf, April—May 1985					
1	108	100.0							108
2	62	100.0							62
3	19	90.5	2	9.5					21
4	15	53.6	12	42.9	1	3.5			28
5	6	28.6	13	61.9	2	9.5			21
6	1	8.3	6	50.0	5	41.7			12
7					5	100.0			5
8					5	100.0			5
9					3	100.0			3
10					2	100.0			2
11					3	100.0			3
12					2	100.0			2
13					3	100.0			3
15					1	100.0			1
17					1	100.0			1
18					1	100.0			1
Over 20					3	75.0	1	25.0	4
Total	211	74.8	33	11.7	37	13.1	1	0.4	282

(table 2 continued)

Age	Sexually immature		Sexually mature: Ovulating for the first time		Sexually mature: Ovulating after giving birth		Sexually mature: Sterile		Total
	No.	%	No.	%	No.	%	No.	%	
				Anadyr Gulf, May—June 1985					
1	43	100.0							43
2	38	100.0							38
3	29	87.9	4	12.1					33
4	9	15.8	37	64.9	11	19.3			57
5	1	2.7	12	32.4	24	64.9			37
6			3	18.8	13	81.2			16
7			1	4.5	21	95.5			22
					17	100.0			17
9					15	100.0			15
10					10	100.0			10
11					8	100.0			8
12					9	100.0			9
13					4	80.0	1	20.0	5
14					7	100.0			7
15					4	100.0			4
16					3	100.0			3
17					1	100.0			1
18					1	100.0			1
19					2	100.0			2
20					1	100.0			1
Over 20					9	90.0	1	10.0	10
Total	120	35.4	57	16.8	160	47.2	2	0.6	339

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Distribution and abundance of the ice forms of pinnipeds on the ice of the Bering Sea in April and May 1987

by G.A. Fedoseyev, Ye.V. Razlivalov and G.G. Bobrova (MoTINRO)

Aerovisual surveys of seals and the walrus on the ice of the Bering Sea have been conducted from time to time since the 1960s by Soviet and American researchers. The most recent aerial survey was carried out in 1979. Considering the fact that the distribution of pinnipeds depends to a certain extent on the year-to-year variability of the ice processes and that there is a need to monitor the changes in their abundance, an aerovisual survey of seals and the walrus was again conducted in 1987.

As in previous years, the survey was carried out from an IL—14 aircraft flying at an altitude of mainly 200 m, and in some cases 100 m (with low clouds). The width of the survey strip was equal to the flight altitude. Whales were noted at any distance.

Abundance was determined in the following way. The data of the transect observations were mapped for 5-minute intervals of the flight. Due to the absence of an automatic orientation system, it was impossible to do an accurate survey of each encounter with pinnipeds by coordinates. Therefore, the data were recorded by 5—minute intervals, and then recalculated for the transects. Using the points where animals were spotted, the rookeries were outlined, their areas were calculated, and the density per sq. kilometre was estimated for each separate rookery.

The seal breeding grounds were first surveyed in April, then again in May; the length of the transects amounted to 20,750 km (Fig. 1, a) and 21,5000 km (Fig. 1, b) respectively.

In the principal seal habitats, the ice masses were surveyed quite thoroughly, except in the Karaginski Gulf and south of it, where it was technically impossible to conduct a survey. The ice off the American coast and west of it was not surveyed entirely either.

The distribution and abundance of some species are characterized below.

Ringed seal. As we know, this species spends a long time in snowy dens during the breeding period and, therefore, is inacessible for observation. Because of this, the range of the ringed seal (Fig. 2, a) in April was incomplete. Nevertheless, the data show that the zone inhabited by this species has expanded in comparison with past years. The tendency towards an increase in the abundance of this species on the pack ice in the Bering Sea has been noted since 1974; it was perhaps the highest in 1987. In May (Fig. 2, b), when the dens thaw and the animals emerge on the surface, the ringed seal formed a nearly continuous range on the greater part of the ice mass in the Bering Sea. Three areas of concentration of this species can be singled out, namely the Karaginski Gulf, the Anadyr Gulf and the area south of it, and the area east of St. Lawrence Is. Apart from the ringed seal on the pack ice, we did not survey the population of this species on the fast ice, with the exception of fragmentary observations in the Karaginski Gulf.

Data on the abundance of the ringed seal are given in table 1. Approximately 1400 ringed seals were counted in the Karaginski and Olyutorski gulfs, and 75,000 in the Anadyr Gulf and central part of the Bering Sea.

The largest number of ringed seals emerge from their dens onto the ice of the Bering Sea at the end of May—beginning of June. This is why the abundance given for the ringed seal is so low. Furthermore, we did not survey the fast ice which, according to past data, is inhabited by up to 40—50% of the ringed seals. This gives grounds for assuming that the total abundance of the ringed seal, including those on the fast ice of the Asian mainland from the western coast of the Anadyr Gulf to the Bering Strait,

amounts to about 125,000—130,000 with the past data taken into account (Fedoseyev, 1979).

Table 1. Aerial survey data on the ringed seal in the Bering Sea

Rookery Nos.	Length of tack, km	Survey area, km^2	No. of animals recorded	Density of animals per km^2	Area of rookeries, km^2	Numbers of ringed seal
			April 1987			
1	10	2	1	0.5	600	300
2	19	3.8	1	0.26	500	130
3	54	10.8	3	0.28	1480	414
4	56	11.2	5	0.45	1200	540
5	65	13	3	0.23	1800	414
6	40	8	2	0.25	1200	300
7	40	8	1	0.125	1500	188
8	94	18.8	6	0.32	5720	1830
9	22	4.4	1	0.23	620	143
10	242	48.4	12	0.25	4040	1010
11	40	8	3	0.38	1100	418
12	16	3.2	1	0.31	320	99
13	18	3.6	1	0.28	400	112
14	20	4.0	1	0.25	440	110
15	152	30.4	7	0.23	1720	396
16	12	2.4	1	0.42	700	294
17	269	53.8	18	0.33	12360	4079
18	10	3.8	1	0.26	640	166
19	43	8.6	3	0.35	2340	819
20	82	16.4	4	0.24	7000	1680
21	62	12.4	4	0.32	3680	1178
22	14	2.8	1	0.36	2020	727
Total						15347
			May 1987			
1	34	3.4	4	1.18	800	944
2	4324	470.06	369	0.79	83280	65791
3	18	1.8	1	0.55	560	308
4	88	7.92	5	0.63	1040	655
5	20	2.0	2	1.0	300	300
6	22	1.1	2	1.82	520	946
7	68	3.84	4	1.04	1800	1872
8	22	1.1	1	0.9	600	540
9	40	2.0	2	1.0	1200	1200
10	336	28.1	20	0.71	11920	8463
11	20	2	2	1.00	320	320
12	8	1.6	1	0.62	200	124
Total						81463

Table 2. Aerial survey data on the harbour seal of the Bering Sea

Rookery Nos.	Length of tack, km	Survey area, km^2	No. of animals recorded	Density of animals per km^2	Area of rookeries, km^2	Numbers of ringed seal
			April 1987			
1	465	93	225	2.42	10960	26523
2	16	3.2	2	0.62	760	471
3	15	3.0	2	0.67	360	241
4	17	3.4	3	0.88	440	387
5	19	3.8	3	0.78	840	655
6	15	3.0	1	0.33	420	139
7	42	8.4	8	0.95	1200	1140
8	18	3.8	1	0.26	320	83
9	20	4.0	2	0.50	480	240
10	18	3.6	1	0.28	480	134
11	312	62.4	75	1.2	5480	6576
12	200	40.0	23	0.58	6500	3770
13	19	3.8	1	0.26	640	166
14	36	7.2	5	0.69	640	442
15	22	4.0	2	0.50	400	200
16	18	3.6	1	0.28	400	112
17	15	3.0	1	0.33	280	92
18	16	3.2	1	0.31	640	198
19	16	3.2	1	0.31	280	87
20	18	3.6	1	0.28	360	101
21	16	3.2	1	0.31	700	217
22	20	4.0	2	0.50	480	240
23	292	58.4	56	0.96	13720	13171
24	16	3.2	3	0.94	960	902
25	18	3.6	3	0.83	1800	1494
26	40	8.0	2	0.25	560	140
27	20	4.0	2	0.50	1520	760
28	20	4.0	1	0.25	1280	320
29	22	4.4	2	0.45	1800	810
Total						58811

Rookery Nos.	Length of tack, km	Survey area, km^2	No. of animals recorded	Density of animals per km^2	Area of rookeries, km^2	Numbers of ringed seal
			May 1987			
1	143	14.3	36	2.52	5840	14717
2	238	36.4	30	0.82	5100	4182
3	20	4.0	1	0.25	960	240
4	20	4.0	2	0.50	920	460
5	575	105.3	43	0.46	16760	7710
6	116	11.6	10	0.86	2400	2064
7	26	2.6	4	1.54	400	616
8	32	3.2	1	0.31	560	174
9	20	2.0	1	0.50	440	220
10	304	30.4	15	0.49	4780	2342
11	56	4.2	5	1.19	840	1000
12	46	3.45	1	0.29	640	186
13	20	1.6	1	0.62	600	372
14	70	7.0	2	0.28	1060	297
15	164	16.4	18	1.1	5240	5764
16	45	4.4	2	0.44	1140	502
17	25	1.5	2	1.33	600	798
18	22	1.1	4	3.64	400	1456
19	21	1.05	1	0.95	640	608
Total						43708

Harbour seal. According to the available literature (Goltsev et al., 1975; Fedoseyev, 1984), the harbour seal forms three local populations in the Bering Sea, namely the Karaginski, the Anadyr and Eastern Bering Sea populations.

The data of the aerial surveys conducted in April—May 1987 (Fig. 3, a), despite a certain discontinuity in the distribution of the ice rookeries, clearly indicate that the harbour seal is confined to the above-mentioned three areas during the breeding period (table 2).

During the first and second ten days of May, the harbour seal rookeries were uniformly distributed in the ice edge zone of the large masses of white ice east of Cape Goven to Bristol Bay (Fig. 3, b).

According to the aerial survey data from the Karaginski Gulf, the numbers of the harbour seal totalled slightly more than 28,000 animals, which is half of the numbers recorded in past years (1976, 1979). This is

due to the fact that the ice in the Ozernovsky and Kamchatsky bays, where the numbers of the harbour seal can be quite high, was not surveyed.

According to the aerial survey of 1987, the largest herd of harbour seals in the Anadyr Gulf numbered 50,000 animals, which is also below that of 1979, when the survey was more complete because of a synchronous Soviet—American survey throughout the entire range.

Not more than 60% of the range of the harbour seal in the Bering Sea was surveyed altogether in 1987. Consequently, the total abundance of this species (60,000) should apparently be increased by 40%, and estimated, as in past years, at a minimum100,000 animals.

Ribbon seal. The breeding grounds of the ribbon seal in the Bering Sea are confined mainly to the ice edge zone. Small breeding grounds are also encountered deep into the ice massif in the zone of open pack ice in the eastern part of the sea (Fig. 4, a). In May, the abundance of ribbon seals on the ice increases, and the range of this species becomes continuous, except in the Karaginski and Olyutorski gulfs, where the distribution of breeding grounds is patchy (Fig. 4, b). This type of distribution of the ribbon seal depends on the ice conditions. As a rule, the ribbon seal forms breeding grounds in the zones of white ice floes alternating with polynyas and fractures. This type of ice is usually found in the ice edge zone which in the Bering Sea is confined to the drop-off zone. Basically, the distribution of the ribbon seal in 1987 did not differ much from that of previous years, with the exception of a slight increase in the area and density of the breeding grounds due to the growth of the herd.

The data in table 3 show that the abundance of the ribbon seal on the ice in May 1987 numbered 117,000 head, i.e. it increased by 15,000 animals as compared with 1979.

Bearded seal. The distribution of the bearded seal on the breeding grounds is shown in Fig. 5, a. Unlike other species of seals, the bearded seal inhabits all types of ice from the sea ice edge up to the shore. However, the main concentrations during the breeding period are confined to the area east of 176° W long. The formation of breeding grounds is influenced to some extent by the ice conditions, particularly the absence of fields of heavy white ice in the eastern part of the Bering Sea. The presence of accessible food organisms (benthos) also plays an important role.

Table 3. Aerial survey data for the ribbon seal of the Bering Sea

Rookery Nos.	Length of tack, km	Survey area, km^2	No. of animals recorded	Density of animals per km^2	Area of rookeries, km^2	Numbers of ringed seal
			April 1987			
1	57	7.99	3	0.38	1160	441
2	6	1.2	1	0.83	320	266
3	10	2.0	3	1.5	560	840
4	22	4.4	1	0.23	1080	248
5	31	6.2	1	0.16	760	122
6	21	4.2	1	0.24	480	115
7	26	5.2	4	0.77	1520	1170
8	14	2.8	1	0.36	320	115
9	977	195.4	131	0.68	25360	17245
10	293	58.6	38	0.78	4600	3588
11	111	22.2	12	0.54	1760	950
12	16	3.2	1	0.31	360	112
13	54	10.8	8	0.74	1200	888
14	326	65.2	22	0.34	18760	6378
15	39	7.8	4	0.51	720	367
16	147	29.4	16	0.54	6880	3715
17	62	12.4	7	0.56	2260	1266
18	23	4.6	1	0.22	1360	299
19	19	3.8	1	0.26	760	198
20	20	4.0	1	0.25	2160	540
21	20	4.0	1	0.25	1400	350
22	22	4.4	1	0.23	440	101
23	23	4.6	1	0.22	480	106
Total						39420
			May 1987			
1	147	14.7	15	1.02	5800	5916
2	6	1.2	1	0.83	324	269
3	179	34.8	15	0.43	5440	2339
4	40	8.0	2	0.25	1720	430
5	122	22.0	11	0.5	4840	2420
6	3228	326.32	493	1.53	64920	99328
7	17	3.4	1	0.29	800	232
8	103	17	2	0.12	1040	125
9	22	1.1	2	1.8	360	648
10	20	2.0	1	0.5	480	240
11	172	9.7	12	1.24	4340	5382
Total						117329

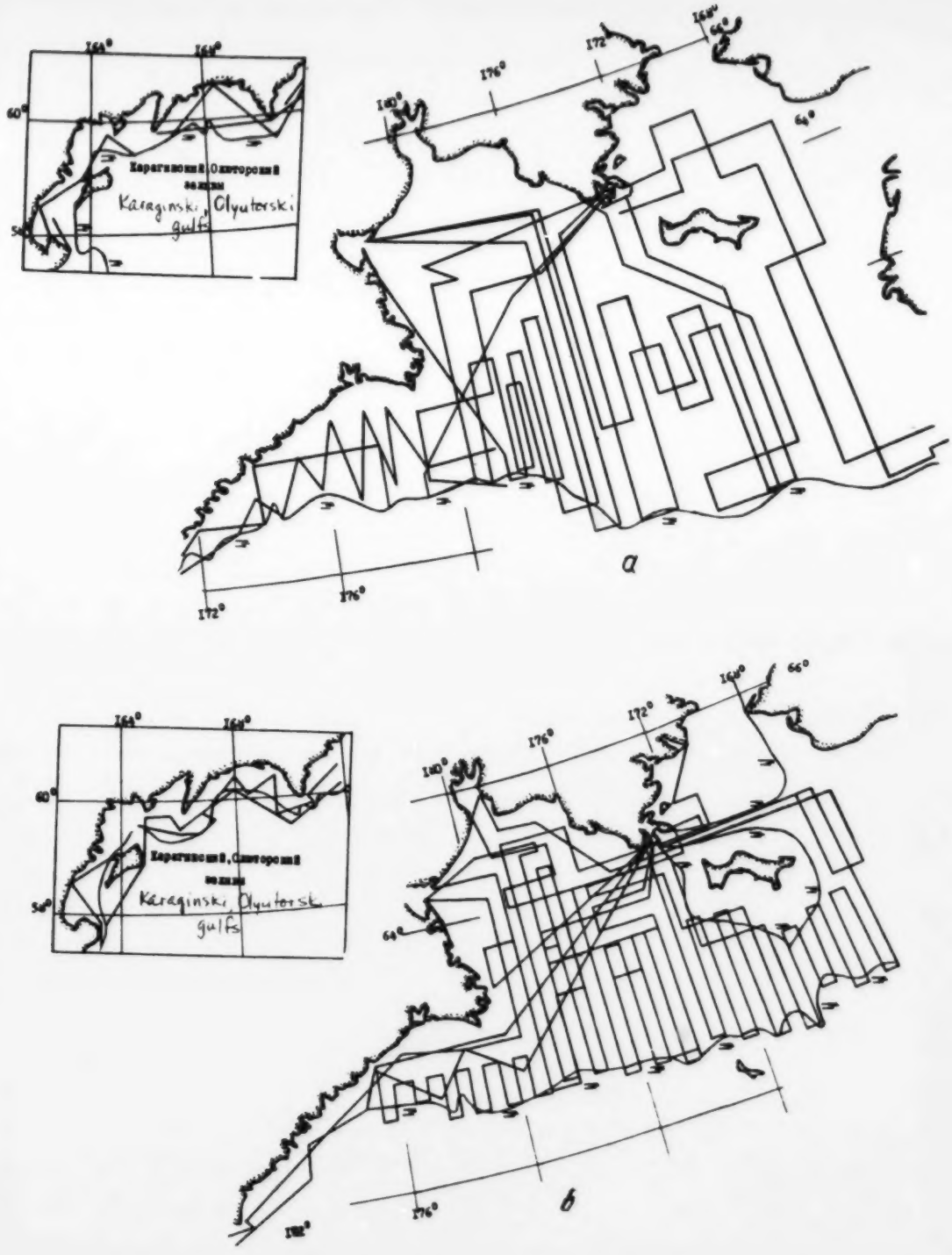

Fig. 1. Map of transects in 1987: a - April, b - May

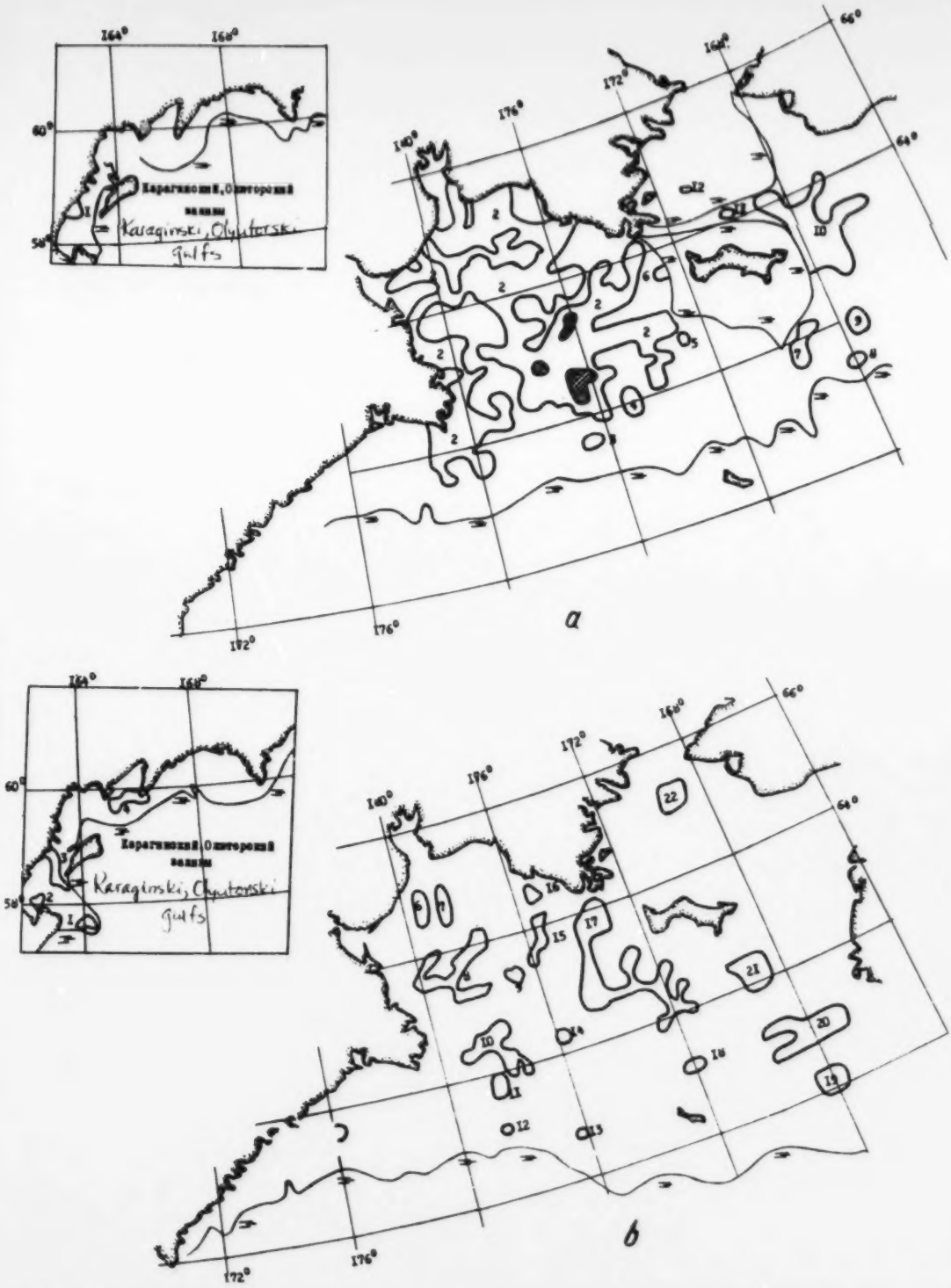

Fig. 2. Distribution of the ringed seal in 1987: a - in April (rookery Nos. as in table 1); b - in May (rookery Nos. as in table 2 (shading signifies absence of animals on the ice)

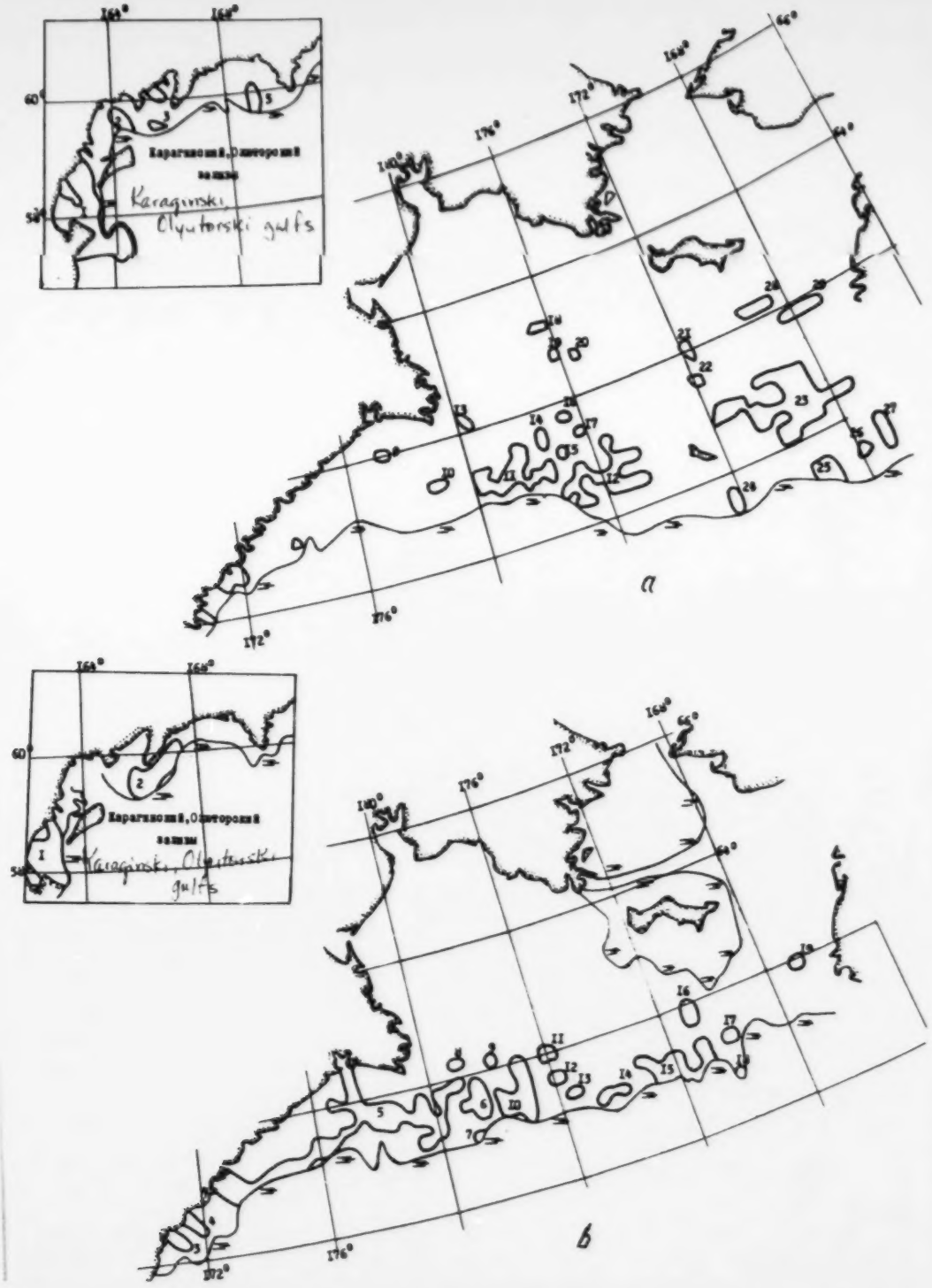

Fig. 3. Distribution of the harbour seal in 1987: a - in April (rookery Nos. as in table 3); b - in May (rookery Nos. as in table 4)

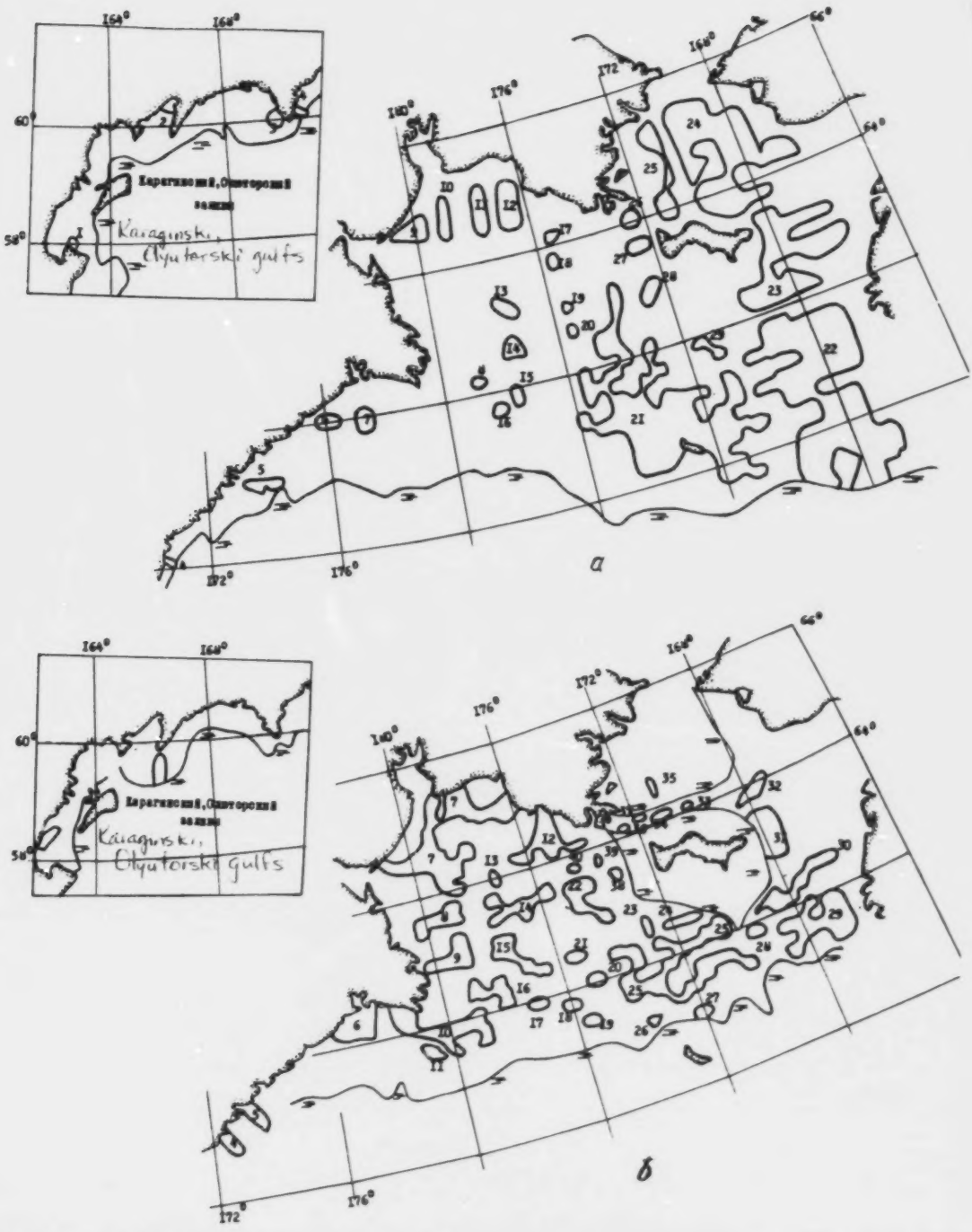

Fig. 5. Distribution of the bearded seal in 1987: a - in April (rookery Nos. as in table 7); b - in May (rookery Nos. as in table 8)

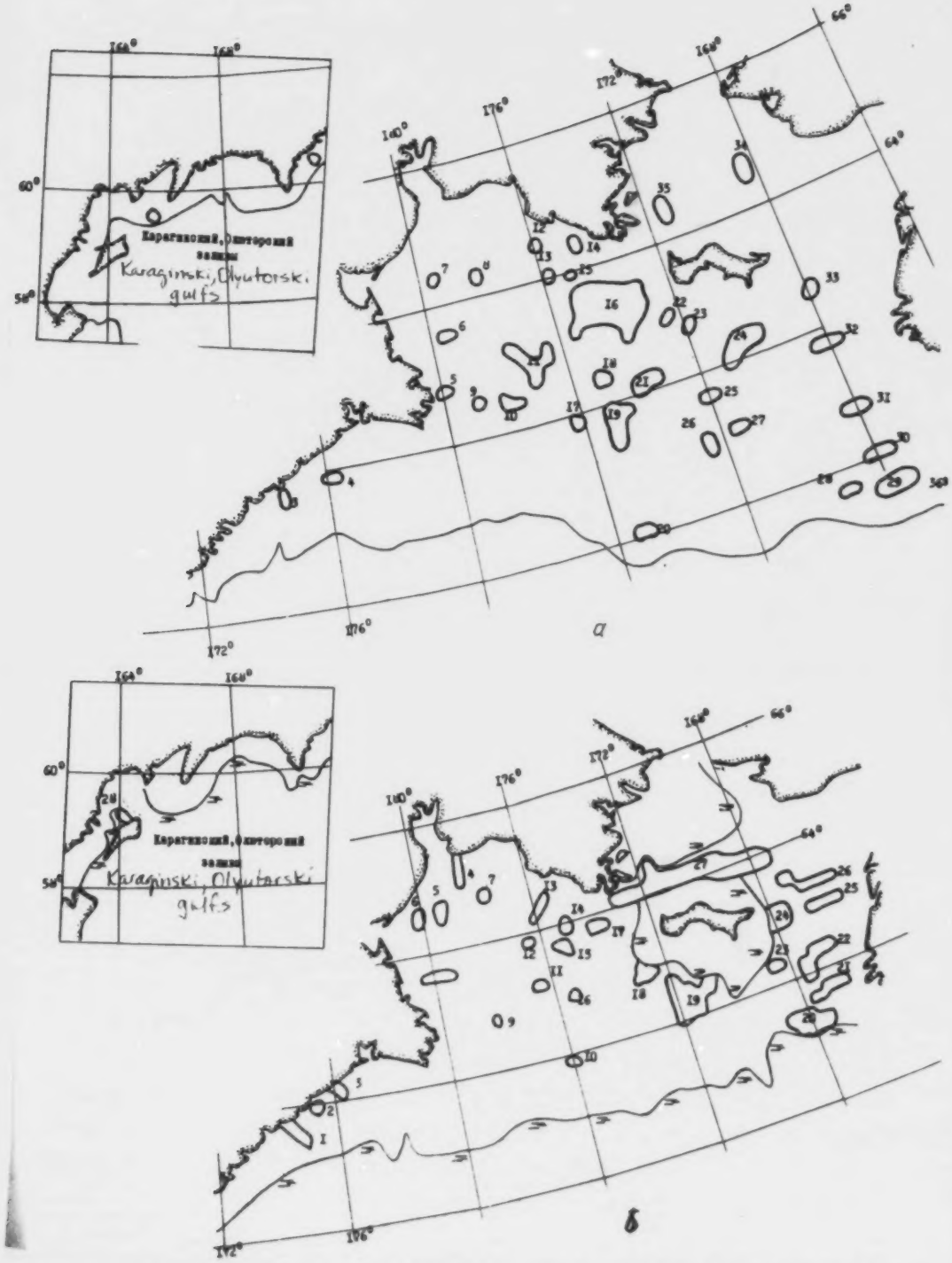

Fig. 6. Distribution of the walrus in 1987: a - in April (rookery Nos. as in table 9); b - in May (rookery Nos. as in table 10)

Table 4. Aerial survey data for the bearded seal of the Bering Sea

Rookery Nos.	Length of tack, km	Survey area, km^2	No. of animals recorded	Density of animals per km^2	Area of rookeries, km^2	Numbers of ringed seal
			April 1987			
1	16	3.2	1	0.31	280	87
2	24	4.8	3	0.62	440	273
3	23	4.6	1	0.22	680	150
4	18	3.6	2	0.56	500	280
5	33	6.6	2	0.30	1100	330
6	22	4.4	1	0.23	780	179
7	40	8.0	2	0.25	1200	300
8	19	3.8	2	0.53	460	244
9	128	25.6	8	0.31	2000	620
10	36	7.2	1	0.14	1460	204
11	40	8.0	2	0.25	1800	450
12	84	16.8	5	0.3	3840	1152
13	24	4.8	2	0.42	1000	420
14	42	8.4	2	0.24	1200	288
15	34	6.8	4	0.59	500	295
16	21	4.2	1	0.24	600	144
17	20	4.0	2	0.5	448	224
18	64	12.8	2	0.16	440	70
19	20	4.0	1	0.25	360	90
20	20	4.0	1	0.25	360	90
21	942	188.4	77	0.41	37680	15449
22	660	132	40	0.30	40400	12120
23	254	50.8	17	0.33	15200	5016
24	313	62.6	33	0.53	22080	11702
25	80	16.0	6	0.38	3300	1254
26	58	11.6	2	0.17	720	122
27	22	4.4	1	0.23	800	184
28	22	4.4	1	0.23	1000	230
29	39	7.8	1	0.13	740	96
Total						52063
			May 1987			
1	20	2.0	1	0.5	800	400
2	10	2.0	1	0.5	480	240
3	44	6.4	3	0.47	1000	470
4	31	5.0	2	0.4	880	352
5	38	5.6	1	0.18	1000	180
6	56	11.2	5	0.45	3720	1674
7	588	56.3	31	0.55	12760	7018
8	74	13.0	4	0.31	2440	756
9	168	24.6	7	0.28	2720	762
10	285	49.0	17	0.35	5920	2072

(table 4 continued)

Rookery Nos.	Length of tack, km	Survey area, km^2	No. of animals recorded	Density of animals per km^2	Area of rookeries, km^2	Numbers of ringed seal
11	41	8.2	2	0.24	700	168
12	168	16.2	14	0.86	4560	3922
13	32	3.2	1	0.31	400	124
14	273.8	31.26	13	0.42	3680	1546
15	174	21.4	9	0.42	2720	1142
16	202	26.4	7	0.26	2400	624
17	40	4	1	0.25	600	150
18	40	3	4	1.3	560	728
19	18	1.8	2	1.1	560	616
20	40	3.6	2	0.56	600	336
21	56	5.6	2	0.36	640	230
22	134	13.4	7	0.52	2760	1435
23	36	3.2	5	1.56	360	562
24	104	7.0	4	0.57	880	502
25	510	47.0	34	0.72	12960	9331
26	20	2.0	2	1.00	400	400
27	20	2.0	1	0.50	620	310
28	20	1.2	1	0.83	560	465
29	212	10.6	24	2.26	7400	16724
30	116	5.8	10	1.7	3960	6732
31	88	8.8	5	0.57	3720	2120
32	42	4.2	2	0.48	1120	538
33	22	2.2	2	0.91	280	255
34	26	3.6	4	1.11	400	444
35	36	7.2	2	0.28	300	84
36	22	2.2	3	1.36	260	354
37	22	2.2	1	0.45	320	144
38	20	2.0	1	0.5	400	200
39	30	3.0	1	0.33	240	79
40	40	4.0	1	0.25	320	80
41	100	9.1	5	0.55	800	440
Total						64709

Table 5. Aerial survey data for the walrus of the Bering Sea

Rookery Nos.	Length of tacks, km	Survey area, km^2	No. of animals recorded	No. of groups recorded	Density of walruses km^2	Area of breeding grounds, km^2	Walrus numbers
			April 1987				
1	20	4.0	15	1	3.75	560	2100
2	22	4.4	1	1	0.23	500	115
3	22	4.4	2	1	0.45	800	360
4	20	4.0	1	1	0.25	600	150
5	20	4.0	2	1	0.50	520	260
6	22	4.4	3	1	0.68	520	354
7	18	3.6	4	2	1.10	400	440
8	20	4.0	1	1	0.25	360	90
9	24	4.8	1	1	0.21	360	75
10	36	7.2	23	2	3.19	800	2552
11	84	16.8	17	5	1.01	2560	2586
12	20	4.0	1	1	0.25	360	364
13	22	4.4	1	1	0.23	320	74
14	20	4.0	1	1	0.25	560	140
15	16	3.2	1	1	0.31	320	99
16	168	33.6	82	10	2.44	8920	21765
17	18	3.6	4	1	1.11	380	422
18	22	4.4	1	1	0.23	560	129
19	94	18.8	74	4	3.94	2640	10402
20	24	4.8	1	1	0.21	720	151
21	52	10.4	26	2	2.50	1120	2800
22	22	4.4	20	2	4.54	720	3269
23	20	4.0	3	1	0.75	600	450
24	92	18.4	63	8	3.42	2800	9576
25	22	4.4	1	1	0.23	500	115
26	22	4.4	6	1	1.36	880	1197
27	18	3.6	10	1	2.78	560	1557
28	20	4.0	1	1	0.25	800	200
29	68	13.6	16	5	1.18	1400	1652
30	24	4.8	1	1	0.21	1160	244
31	24	4.8	11	2	2.29	880	2015
32	22	4.4	3	1	0.68	1040	707
33	40	8.0	35	3	4.38	480	2102
34	22	4.4	20	1	4.54	1120	5085
35	16	3.2	51	3	15.94	780	12433
36	20	4.0	16	2	4.0	720	2880
Total							88910

(table 5 continued)

Rookery Nos.	Length of tacks, km	Survey area, km^2	No. of animals recorded	No. of groups recorded	Density of walruses km^2	Area of breeding grounds, km^2	Walrus numbers
			May 1987				
1	20	4.0	3	1	0.75	1200	900
2	24	4.8	2	1	0.42	440	185
3	38	7.6	103	3	13.2	600	8160
4	20	2.0	150	5	75	1120	8400
5	22	4.4	6	2	1.36	800	1088
6	22	4.4	21	2	4.77	600	2862
7	22	2.2	5	1	2.27	480	1090
8	16	3.2	2	1	0.62	1160	719
9	22	4.4	2	1	0.45	400	180
10	18	0.9	2	1	2.22	480	1065
11	19	0.95	17	2	17.89	520	9303
12	18	0.9	3	3	3.3	400	1320
13	18	1.8	1	1	0.56	1080	605
14	30	4.8	2	2	0.48	600	288
15	56	7.3	3	2	0.41	1000	410
16	20	2.0	1	1	0.5	700	350
17	62	6.2	15	3	2.42	800	1936
18	132	18.8	134	8	7.13	1160	8271
19	257	21.8	183	19	8.39	4800	40272
19*	-	-	1709	83	-	-	1709
20	110	5.5	61	7	11.1	2920	32412
21	42	2.1	11	2	5.2	1440	7488
22	66	3.3	22	3	6.67	2280	15208
23	22	1.1	1	1	0.9	600	540
24	46	4.6	8	4	1.74	1960	3410
25	20	2.0	3	2	1.5	1400	2100
26	42	3.1	37	4	11.94	2000	23880
27	744	68.7	228	22	3.32	8920	29614
27*	-	-	1511	28	-	-	1511
28	22	4.4	20	1	4.5	600	2700
Total							207976

*We encountered large congregations of walruses which were not included in the calculation of density, but were recorded nominally.

In May, despite the discontinuous nature of the rookeries, the distribution of the bearded seal was more uniform throughout the ice masses (Fig. 5, b). As the ice melted and underwent dynamic destruction, the bearded seal migrated to the western shore of the Anadyr Gulf.

The numbers of the bearded seal on the ice breeding grounds totalled 52,000 in April, and about 65,000 in May (table 4). It should be said that the numbers of this species on the ice were similar in the preceding years of the aerial survey (Fedoseyev, 1979). There is no doubt that the abundance of the bearded seal at the rookeries does not reflect the entire stock of the population, due to the high diurnal activity of the species and its well-defined spring migration from the Bering Sea to the Chukchi Sea. On the other hand, the constancy of its numbers on the ice throughout the years of the aerial survey indirectly indicates that the bearded seal stocks in the Bering Sea are in good condition. The current abundance figure of 250,000 head for the bearded seal of the Bering Sea is probably acceptable for today's balanced state of the population (Kenyon, 1972).

Walrus. The investigations on the distribution of walruses in the Bering and Chukchi seas have recently been correlated with the seasonal changes of the range taken into account (Fay, 1982; Fedoseyev, 1982). Nevertheless, the areas inhabited by walruses during the winter and early spring have not been studied sufficiently with regard to the annual changes in ice conditions which in many ways determine the distribution of these animals.

Our data on the distribution of walruses in April and May 1987 (Fig. 6) show that the range of this species may extend much farther westward (towards Cape Navarin and the Anadyr estuary) than noted earlier. At the same time, a comparison of the data for April and May shows a clear tendency towards shifting of the main mass of walruses from west to east, despite the fact that some of the animals remain on the Koryak coast.

The numbers of the walrus for the different periods and areas are given in table 5. These data do not reflect the total abundance of this species, since its range in the eastern part of the sea was not surveyed completely.

The maximum abundance of the walrus stock in the areas of ice surveyed amounted to approximately 208,000 head.

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Data on the abundance of the ice forms of seals in the Karaginski Gulf of the Bering Sea in 1986—1987

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(Kamchatrybvod)

At the present time, the ice forms of seals in the Far Eastern seas are being harvested with the structure of their populations taken into account. Off the eastern coast of Kamchatka, local populations are distinguished in two species of seals, the harbour seal and the ringed seal (Goltsev, Popov, Yurakhno, 1975; Fedoseyev, 1984). The populational status of the breeding and moulting congregations of the ribbon seal and bearded seal that form in this area every year has not been studied well enough. The hunting limitation for the seals off Eastern Kamchatka is based on the abundance of

their local populations or reproductive moulting groups. The numbers of the Phocidae on the ice of the Bering Sea (1974, 1976, 1979 and 1987) are systematically determined by specialists of the Magadan branch of TINRO (Fedoseyev, 1979; Fedoseyev et al., see present compendium). The transect method used in this case is a trustworthy one, and enables us to assess the abundance of animals on the ice. However, during the investigations off the eastern coast of Kamchatka in 1979 and 1987, TINRO workers of the Magadan branch deviated from the usual surveying procedure, which made it impossible to judge the abundance of seals on the ice in this area. Instead of a tack grid, several linear survey routes were executed off the eastern coast of Kamchatka (Fedoseyev, 1979; Fedoseyev et al., present compendium, figs. 1, 2); on the basis of these, it was impossible to outline the area inhabited by the harbour seal in 1979, or the area inhabited in 1987 by all the species of seals as they are shown on the maps, since a 200-metre-wide transect does not allow us to record the presence or absence of animals within several tens of kilometres from the flight route. Significant errors in abundance determination may result because of incorrect determination of the area inhabited by the species.

In our opinion, investigators have wrongly concluded that the status of the groups of all the species of seals off the coast of Eastern Kamchatka from 1974 to 1987 was satisfactory. This conclusion also contradicts the observations of experienced hunters and game wardens of the "Karaginski Gospromkhoz" of the Kamchatka Region (Yu.Ya. Biryukov, B.N. Klochev, I.S. Stryuchenko, V.G. Tatarinov, N.P. Bondyrev, et al.), who, with over 10—15 years of experience, believe that the numbers of seals in the Karaginski Gulf have dropped considerably.

Therefore, we have undertaken to examine the data of two of our own aerial surveys of seals on the ice of the Karaginski Gulf from an AN-2 aircraft, which appear to confirm the observations of the hunters regarding the main species hunted, the harbour seal.

Both seasons, the work was carried out during the moulting period, the most dynamic period at ice rookeries. At this time (middle—end of May), the ice off Eastern Kamchatka is found mainly in the Karaginski Gulf and in a narrow strip in Ozernyi Bay. Therefore, the survey data on the

Karaginski Gulf can, in our opinion, be used to characterize the status of the seal groupings off the coast of Eastern Kamchatka as a whole.

Like the specialists of the Magadan branch of TINRO, we also used the transect method to determine the abundance of seals. However, our estimates were based on somewhat different factors. Since the habitat of each species of seals is confned to certain types of ice, which are quite clearly differentiated within the water area of the Karaginski Gulf, we outlined the ice conditions in the gulf during our preliminary flights at high altitudes. We then superimposed the tack grid on it, attempting to cover all the ice types uniformly with transects. During the aerial surveys along the grid lines, we detailed and verified the ice conditions while counting the animals. As a result, we derived the density of each species of seals for each type of ice (fast ice, medium floes, small floes, etc.) and produced a fairly detailed map of the ice conditions. By means of a contour map in a scale of 1:5 km and a measuring grid, we determined the area of the differentiated ice types. It is on the basis of these two indices that the numbers of each species of seals were calculated (see table).

All the work was carried out under good visibility conditions, on a clear or almost cloudless day, with winds not exceeding 7—8 m/s. The distances were determined by the speed of the aircraft (kept at about 160 km/hr) with the corrections for wind velocity taken into account. The animals were observed and counted from the copilot's seat. The width of a transect was always equal to the flight altitude, and was usually 200 m. It was 100 m only on certain tacks above fast ice in Ukinskaya Bay in 1986, and 300 m in 1987.

The correction factors for omission of the animals that were in the water at the time of the flight were determined by observing the activity of the seals amidst the ice from an outboard motor boat simultaneously with the aerial surveys in 1987.

In 1986, all the work on the survey tacks (Figs. 1, 2) was carried out in a single day, on May 12th. On May 13th, the fast ice was surveyed in Karaga and Ossora bays and in the Makar'yevskaya, Tymlat and other lagoons. In 1987, the surveys in the southern part of the gulf (south of the Karaginski Is.—Ivashka R. tack) were carried out on May 30th; two small tacks (from the Dranka R. and Karaga Bay) were carried out on June 2nd,

and one broken course along the "northern" part of a thick ice cake was executed on June 5th.

The distribution of seals on the ice and the estimates of their abundance are shown in Figs. 1 and 2, and in the table.

Ringed seal. From the second half of May and up to the end of the ice thaw in this area (up to June 17—28th), this species is encountered only in the southern part of the gulf, mainly in Ukinskaya Bay. It prefers to haul out on fragments of floes, small floes, and on fast ice near holes (Figs. 1, 2). It is rarely encountered on ice cakes, usually when small floes have already disintegrated. The area of the habitat at this time is directly dependent on the area of the listed preferred types of ice. It is rarely encountered in Karaga and Ossora bays, and in the Makaryevskaya, Tymlat and other lagoons, and usually one at a time.

The abundance of ringed seals found on the ice amounted to 3600 in 1986, and 4900 in 1987. With the correction for the animals in the water (not determined in 1986, 20% in 1987), the abundance of the ringed seal in the Karaginski Gulf in 1987 was estimated at 6000. It can be said for comparison that the abundance of the ringed seal on the ice in 1984 and 1985 was estimated at 4600 and 4700 respectively by the same method.

Harbour seal. From the second half of May to the beginning of June, this species prefers to haul out on consolidated (6—10-point), usually hummocky ice cakes. Large congregations are observed in the vicinity of the Ozernyi Peninsula. During the years when the sea ice cover is heavy (as in 1987) and the ice also lasts in the northern part of the gulf, the harbour seal forms congregations farther into the interior of the floes (Fig. 1). The harbour seal was hardly ever encountered on open pack ice with a 1—5-point density. During the aerial surveys in 1987, two of the authors working from a boat saw only one harbour seal swimming in the water amidst this type of ice in the Litke Stait (between Ossora Bay and Karaginski Is.) during the entire day.

The abundance of the harbour seal on the ice of the gulf was estimated at 2200 in 1986, and 9500 in 1987. With the correction for the animals found in the water at the time of the survey (13.0% in 1987), the abundance of the harbour seal in the Karaginski Gulf was 10,700 at the end of May—beginning of June 1987. When a similar method of survey was

used in 1984, the estimated abundance of the harbour seal on the ice of the gulf was 8200. In 1986, because of the light ice cover on the sea, the harbour seals were probably no longer on the ice at the time the survey began, though the hunters of the Karaginski Gospromkhoz note that the numbers of the harbour seal were low throughout the spring hunting season that year (personal communication).

In 1979, the numbers of the harbour seal off the eastern coast of Kamchatka were estimated at 55,000 twice, in April and in May (Fedoseyev, 1979). In May, this species was concentrated mainly in the Karaginski Gulf, as was the case during our surveys. In 1979, the numbers of the harbour seal in the gulf were probably overestimated due to the above-mentioned factors.

The survey data gathered on the harbour seal during the summer period, when the animals are concentrated in the areas of salmon spawning migrations and coastal hauling-out grounds, can be used for comparsion. In August 1985, 12,500 harbour seals were recorded in the Karaginski Gulf, and approximately 20,000 for the entire eastern coast (the numbers of the entire population) (Burkanov, 1986), i.e. these figures also come closer to the results of our spring surveys. Therefore, without claiming that our results are absolutely accurate, we turn our attention to the necessity of thoroughly analyzing all the populational indices of this group of seals off Eastern Kamchatka, since it is a commercial species in this area.

Ribbon seal. This species appears in the gulf in significant numbers at the end of May. Like the harbour seal, it is encountered mainly on ice cakes of 6—10-point consolidation, in the southern part of the gulf, on the outside of the ice edge. The numbers of this species fluctuate significantly from year to year. Four thousand three hundred ribbon seals were noted on the ice in 1987, 2300 in 1986 when there was less ice on the water, and 15,800 in 1984. In 1979, the numbers of this species in May was estimated at 12,000 (Fedoseyev, 1979). The hunters of the Karaginski Gospromkhoz also confirm the high dynamics of the ribbon seal congregations in the gulf (personal communication). Being a more active species, the ribbon seal probably migrates randomly from the northern part of the Bering Sea to the southern part, and back again.

Summary of aerial survey data on the true seals of the Karaginski Gulf in 1986—1987

Type of ice	Area occupied (km)	Surveyed,		Ringed seal			Harbour seal			Bearded seal			Ribbon seal		
		km	km^2	A	B	C	A	B	C	A	B	C	A	B	C
May 12 - 13, 1986															
I. Fast ice	700	106.6	21.9	37	1.69	1200	-	-	-	-	-	-	-	-	-
II. Medium floes	710	90.4	18.1	53	2.93	2000	1	0.06	50	20	1.11	800	-	-	-
III. Small floes	440	40.1	8.0	4	0.50	220	8	1.00	440	4	0.50	220	6	0.75	330
IV*. Ice cakes	2510	176.1	35.2	3	0.09	225	24	0.68	1700	1	0.03	75	28	0.80	2000
Total	4360	413.2	83.2	-	-	3645	-	-	2190	-	-	1095	-	-	2330
May 30, June 2-3, 1987															
I. Fast ice	590	70.2	17.0	28	1.70	1000	-	-	-	-	-	-	-	-	-
II. Medium floes	440	69.4	13.9	24	1.73	1972	-	-	-	1	0.07	80	-	-	-
III**. Medium floes	450	18.9	3.3	9	2.37	1000	-	-	-	-	-	-	-	-	-
IV***. Small floes	870	99.7	19.9	21	1.06	900	2	0.1	87	-	-	-	14	0.7	609
V. Ice cakes, "southern"	1110	84.4	16.9	-	-	-	60	3.60	4000	-	-	-	50	2.95	3274
VI. Ice cakes, central	1620	99.1	19.8	-	-	-	4	0.22	356	1	0.05	81	5	0.25	405
VII. Ice cakes, "northern"	2125	82.7	16.5	-	-	-	39	2.36	5015	7	0.42	893	-	-	-
Total for all types of ice	7905	524.4	107.8	-	-	4872	-	-	9458	-	-	1054	-	-	4288

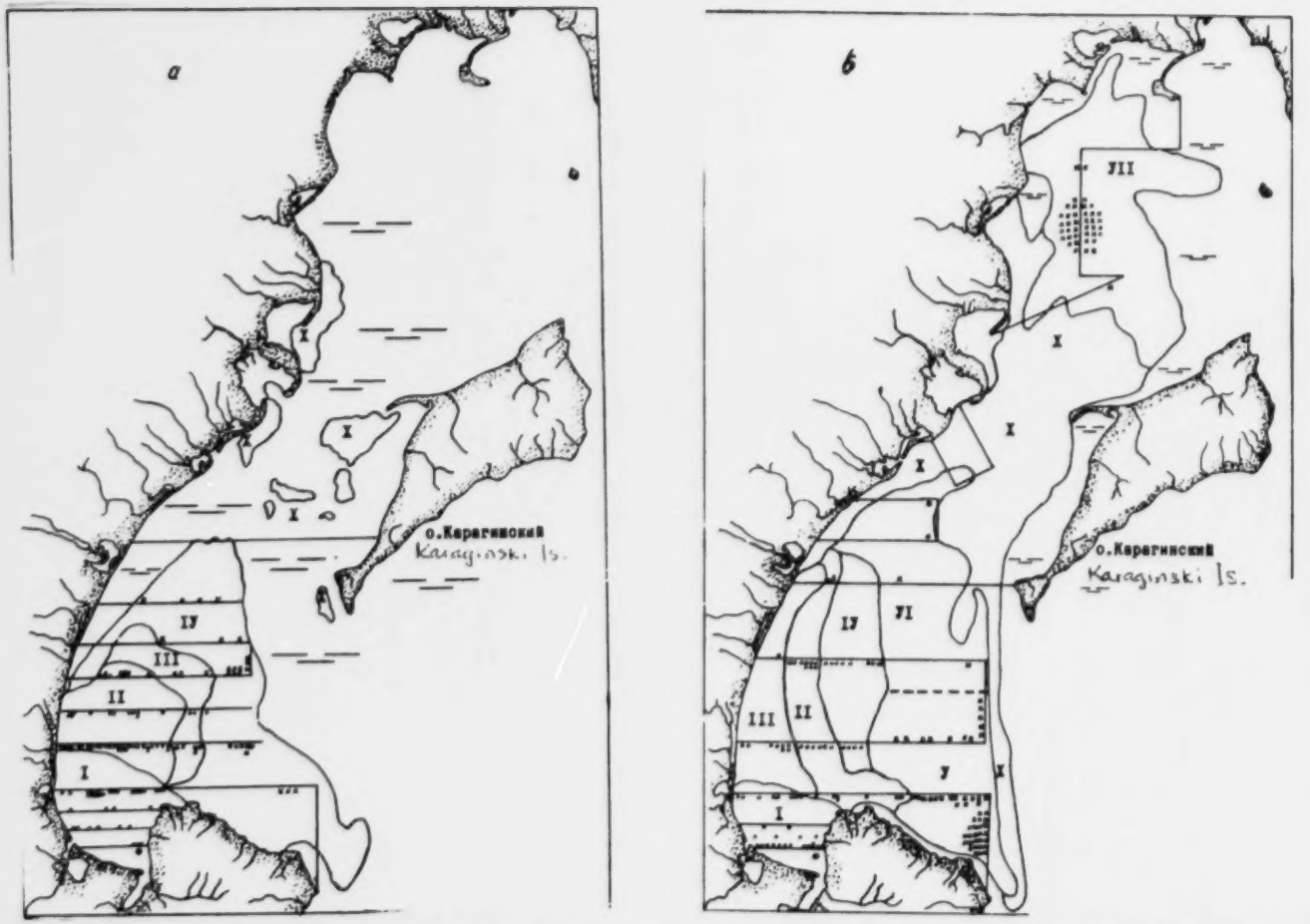

Fig. 1. Distribution of the ringed seal and harbour seal on different types of ice in the Karaginski Gulf:

a - 12-13 May 1986; b - 30 May—5 June 1987; • - ringed seal; x - harbour seal; ___ - survey transects; I—III - type of ice (see table); X - 1—4-point ice cakes

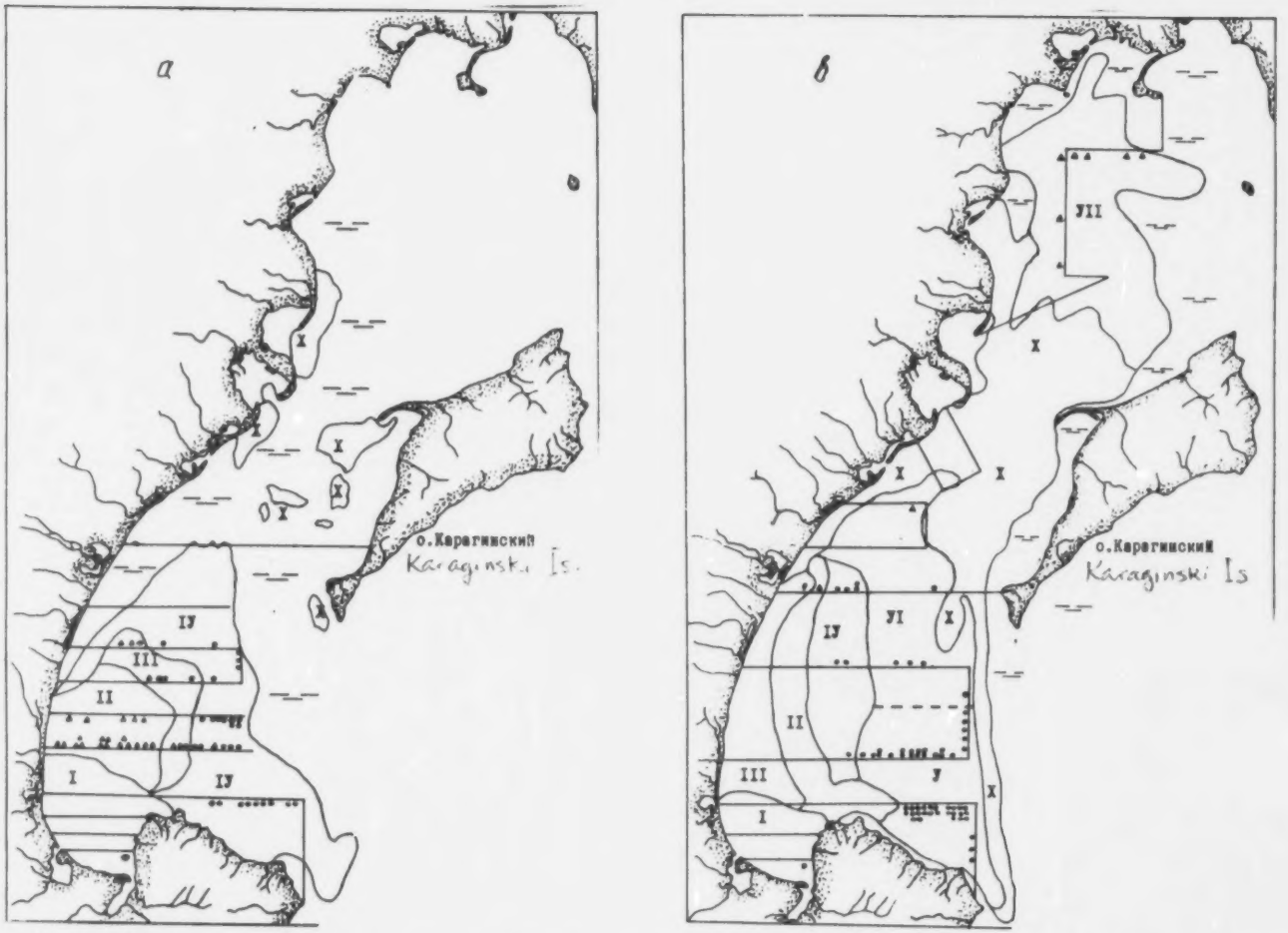

Fig. 2. Distribution of the ribbon seal and bearded seal on different types of ice in the Karaginski Gulf: a - 12-13 May 1986; b - 30 May—5 June 1987; o - ribbon seal; ▲ - bearded seal. Remaining symbols as in Fig. 1

Bearded seal. The distribution of the bearded seal in the Karaginski Gulf depends greatly on the ice conditions. During the years when there is little ice, when the latter can be found only in the southern part of the gulf in the second half of May—beginning of June, this species is encountered on different types of ice not far from the shore. During the years when the ice cover is quite substantial, the bearded seal is encountered more frequently in the northern half of the gulf, but the density of its occurrence is low everywhere.

The numbers of the bearded seal are not high in the gulf. They were estimated at about 1100 in 1986 and 1987, and at approximately 2000 in 1984. It should be said that, despite the usual underestimation of this species during an aerial survey, its absolute numbers in the gulf during these years were slightly higher than the figures given above.

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Note to table: A - number of seals (head) along routes; B - average density on transects (head per sq. km); C - estimated abundance (head); II, III - 7-9 points; III** - 4-5 points; IV* - 6-10 points; IV*** - 8-9 points; V, VI, VII - 6-9 points

Results of an aerial survey of coastal seal rookeries in the Sea of Okhotsk in 1986

by S.I. Lagarev (TINRO)

An aerial survey of the coast of the Sea of Okhotsk was carried out from a MI-8 helicopter to study the distribution of coastal seal rookeries and to estimate the abundance of these animals. The results of our study are given in tables 1—5.

Table 1. Hauling-out grounds and coastal congregations of harbour seals of the Tatar Strait and Sakhalin Is.

Date of survey	Location of hauling-out grounds	No. of seals
	Western shore of Tatar Strait	
7/09	South of Cape Krestovozdvizhensky	38
	Vicinity of Cape Vstrechnyi	25
	Vicinity of Cape Uspenye	53
	North of Cape Uspenye, 2 km*	300
	Sakhalin Is.	
7/09	South of Cape Lomakon, 4 km	28
	Traverse of Kalinino settlement	50
	Cape Kuznetsov	54
	East of Cape Krilson**	37
	South of Ulyanov settlement, 10 km*	315
8/09	Cape Tomari-Aniva	80
	Cape Yunony	200
	Vicinity of Ozersky settlement	55
	Vicinity of Igrivaya settlement (south of Muravyev settlement)	25
	Vicinity of Cape Slyuda*	33
	North of Sivuchya cliff*	12
	Cape Pavlovich*	35
	Cape Cornelius	400
	Cape Yefstafiy	350
	Cape Menaputs	200
	Cape Veselyi	300
	South of Cape Velikan, 3 km	200
	Cape Zheleznyi	100
	Cape Stradnyi	100
	Eastern (Okhotsk) extremity of Cape Svobodnyi	200
	Western (Mordvinov Gulf) side of Cape Svobodnyi	550
	Vicinity of Okhotskoye settlement	550

Date of survey	Location of hauling-out grounds	No. of seals
	Cape Lesnoy	430
	Cape Bykov	300
	Cape Ostrovnoy	180
8/09	South of Cape Senyavin, 2 km*	105
	North of Cape Senyavin, 3 km	40
	Vicinity of Starodubskoye settlement	30
	Traverse of Arsentyevka settlement	23
	Traverse of Pugachev settlement*	55
3/09	North of Kotikovo settlement	183
	Cape Gergiy	26
	North of Cape Terpeniya, 8 km	50
	Vicinity of Cape Davydov*	126
	Cape Povorotnyi (north of the sunken barge)	10
	Cape Popov***	32
	South of Cape Gvozdev, 2 km	60
	South of Cape Ratmanov	56
	Mouth of Chaivo Bay	1700
	Mouth of Piltun Bay*	12
9/09	East of Cape Yelizaveta*	50
	Western extremity of Cape Yelizaveta	70
	South of Cape Mariya	270
3/09	Mouth of Pomr Bay	12
	Northern extremity of Ush Is.	30
9/09	South of Cape Chintai, 2 km	32
	Vicinity of Cape Korsakov*	16
	Individual encounters enroute	16
	TOTAL	7762

* in the water
**250 northern sea-lions and 8 bearded seals encountered
***Bearded seals encountered

Table 2. Hauling-out grounds and coastal congregations of seals in the western part of the Sea of Okhotsk

Date of survey	Location of hauling-out grounds	Species	No. of seals
	Mainland seacoast		
10/09	Cape Mofet	Harbour seal	50
10/09	Reineke Bay	Harbour seal	180
	West of Cape Aleksandr, 1 km	Bearded seal	2
		Harbour seal	20
	Reineke Is., southern side	Harbour seal	500
	Aleksandra Bay, near Cape Topograficheskiy	Bearded seal	11
	Southern side of Cape Lamsdorf	Harbour seal	6
	Top of Nikolai Bay, mouth of the Usalgin R.	Harbour seal	25
	Central part of western shore of Nikolai Bay, south of the Mukhtelya base	Bearded seal	260
13/09	Uykan Bay	Harbour seal	125
	Korel Bay	Harbour seal	30
		Bearded seal	4
	Mamga Bay, northern sand bar		25
	Mamga Bay, southern sand bar		7
14/09	Cape Nosorog		6
	Shantar Isls.		
13/09	Cape Gaikovsky, M. Shantar Is.	Harbour seal	300
	Bay north of Cape Yugozapadnyi of M. Shantar Is.	Harbour seal	20
	Kamni Diomida	Bearded seal	35
14/09	Cape Mramornyi, B. Shantar Is.	Bearded seal	10
	Cape Bokovikov, M. Shantar Is.	Harbour seal	300
	Priglubokaya Bay, M. Shantar Is.*	Bearded seal	8
	Otkrytaya Bay south of Cape Razdelnyi of B. Shantar Is.	Bearded seal	132
13/09	Utichiy Is.	Bearded seal	550
14/09	Cape Primetnaya Skala, Feklistov Is.	Bearded seal	11
	Cape Belyi, Feklistov Is.	Bearded seal	10
	Vicinity of Belyye Skaly, Feklistov Is.	Bearded seal	6
	Sakharnaya Golova Is.	Harbour seal	15
	Sivuchi Kamni Is.	Harbour seal	730
	Individual encounters enroute	Harbour seal	9
		Bearded seal	5
Total number of seals encountered		Harbour seal	2210
		Bearded seal	1100

*in the water

Table 3. Hauling-out grounds and coastal congregations of seals on the northern coast of the Sea of Okhotsk

Date of survey	Location of hauling-out grounds	Species	No. of seals
5/08	Gertner Bay	Harbour seal	5
	Mouth of the Ola R.	Harbour seal	2800
	Melkovodnaya Bay	Harbour seal	9
	Zavyalov Is.	Harbour seal	8
	Between Cape Alekin and the mouth of the Burgauli R.	Northern sea-lion	350
		Harbour seal	305
	Siglan Bay*	Harbour seal	215
7/08	Zveroboyev Bay*	Harbour seal	9
	Kekurnyi Bay, north of Cape Vnutrenniy	Harbour seal	55
	Matykl Is.	Northern sea-lion	600
	Mouth of Perevolochnyi Bay	Harbour seal	1000
	Sand bars south of Cape Iretsky	Harbour seal	900
	Mouth of the Takhtayamy R.	Harbour seal	20
30/07	Mouth of the Ugulan R.	Harbour seal	160
	South of the Bulun R. estuary	Ringed seal	80
	Mouth of the Kananygi R.	Harbour seal	70
	Mouth of nameless river, north of Cape Viliginsky	Harbour seal	40
	Mouth of the Viligi R.	Harbour seal	500
	Mouth of the Propashcha R.*	Harbour seal	15
	Vicinity of Cape Gorka*	Harbour seal	20
	Mouth of the Tavattam R.	Harbour seal	180
	Mouth of the Uykan*	Harbour seal	10
	Mouth of the nameless river, north of Cape Storozhevoy	Harbour seal	40
	Western part of Nayakhanskaya Bay	Harbour seal	150
	Varkhalamskaya Bay*	Harbour seal	56
7/06	North of Cape Varkhalamsky, 4-5 km	Harbour seal	36
30/07	Chaibukh Bay	Harbour seal	40
	Mouth of the Chaibukh R.*	Harbour seal	50
20/07	Topolovka Bay	Harbour seal	25
	Cape Granitnyi	Harbour seal	100
	Vnutrennyaya Bay**	Bearded seal	2
20/07	Cape Povorotnyi	Harbour seal	4
	Individual encounters enroute	Harbour seal	19
		Ringed seal	2
Total number of seal		Harbour seal	6831
		Northern sea-lion	950
		Ringed seal	82

*in the water
**on the ice

Table 4. Results of a second survey of the coast of Penzhina Bay

Date of survey	Location of hauling-out grounds	Species	No. of seals
23/10	Bay north of Cape Sredniy*	Harbour seal	65
	Gertner Bay*	Harbour seal	25
26/10	Mouth of the Ola R.**	Harbour seal	200
23/10	North of Cape Rechnyi, 3 km*	Harbour seal	40
	Nerpichya Bay	Harbour seal	50
	Cape Alevin—mouth of Burgauli R.*	Harbour seal	75
	North of Cape Kornilov, 3 km*	Harbour seal	50
26/10	Siglan Bay*	Harbour seal	350
	Between Cape Vostochnyi and Cape Yevreinov*	Harbour seal	30
	Babushkin Bay - south of the Evkun estuary*	Harbour seal	350
	TINRO Bay**	Harbour seal	150
	Shkhiperov Bay**	Harbour seal	250
21/10	Kekurnyi Bay*	Bearded seal	12
	Vicinity of Cape Sredniy*	Harbour seal	240
26/10	Iretskiy Bay*	Harbour seal	600
	Mouth of the Ugulan R.*	Harbour seal	15
27/10	Vicinity of Cape Tavattamsky*	Harbour seal	10
	Varkhalamskaya Bay*	Bearded seal	8
30/10	Gizhiga Bay**	Ringed seal	5700
		Harbour seal	240
		Bearded seal	60
27/10	Sredniy Bay, Taigonos Peninsula*	Harbour seal	110
	Telan Is.	Harbour seal	60
	Vnutrennyaya Bay**	Bearded seal	20
30/10	Melkovodnyi Bay, south of the Yelistratov Peninsula**	Ringed seal	150
		Harbour seal	30
		Bearded seal	30
	Aypin Bay - Ennoveyet estuary**	Ringed seal	1500
		Bearded seal	800
		Harbour seal	50
	Vicinity of Cape Pupyr**	Ringed seal	25
		Harbour seal	10
	Dobzhansky Is.	Ringed seal	5
		Bearded seal	10
		Harbour seal	10
	Individual encounters enroute	Ringed seal	18
		Harbour seal	7
		Bearded seal	22
Total number of seals		Ringed seal	7398
		Harbour seal	3017
		Bearded seal	972

*in the water
**on the ice

Table 5. Hauling-out grounds and coastal congregations of seals on the western coast of the Kamchatka Peninsula (north to south)

Date of survey	Location of hauling-out grounds	Species	No. of seals
29/07	Cape Podkagernyi	Harbour seal	150
26/07	Mouth of the Shamanka R.*	Harbour seal	80
26/07	North of Cape Bezymyannyi, 2 km	Harbour seal	15
	North of Cape Ostrovnoy, 5 km	Bearded seal	3
		Ringed seal	7
	South of Cape Ostrovnoy, 3 km	Harbour seal	45
	North of the Palana R., 7 km	Harbour seal	50
	Mouth of the Palana R.	Harbour seal	20
	Mouth of the Pyatibratka R.	Harbour seal	200
	Mouth of the Voyampolka R.	Harbour seal	5
	Mouth of the Kovgory R.	Harbour seal	9
	Mouth of the Tigil R.	Harbour seal	500
		Bearded seal	20
	Cape Omgon	Harbour seal	9
	Mouth of the Moroshechnaya R.	Harbour seal	12
21/07	Mouth of the Bolshaya R.	Harbour seal	700
	Mouth of the Utka R.	Harbour seal	650
	Individual encounters enroute	Harbour seal	12
		Ringed seal	3
		Bearded seal	2
Total number of seals		Bearded seal	25
		Harbour seal	2445
		Ringed seal	10

*in the water

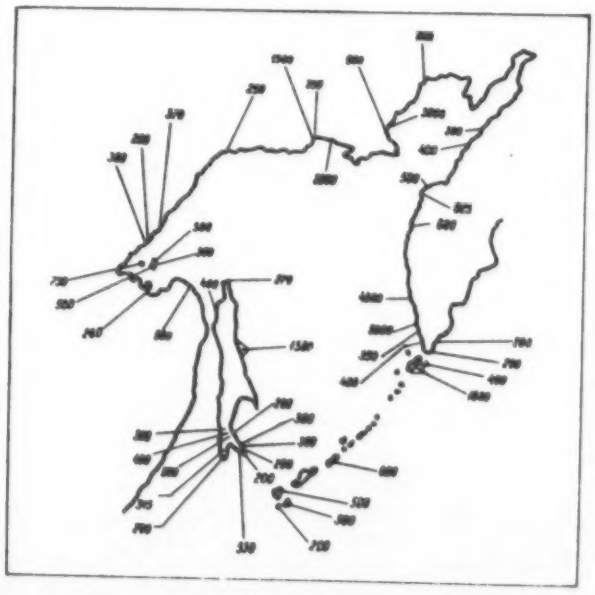
The mainland coast of the Tatar Strait was surveyed from the mouth of the Samarga R. northward to the town of Sovetskaya Gavan, and the coast of Sakhalin Is. was surveyed completely. A complete survey was also done of the Shantar archipelago of islands and the western part of the Sea of Okhotsk. Due to variable cloudy weather, we surveyed the western coast of the Kamchatka Peninsula from the mouth of the Moroshechnaya River to the mouth of the Kikhchik R. and from the mouth of the Bolshaya R. to Cape Vodopadnyi.

We surveyed the northern coast of the Sea of Okhotsk twice (see tables 3 and 4). The results of the second survey show that because of the transition of meteorological processes to a winter cycle (rapid cooling of shallow waters, appearance of ice in the tidal zone), the seals do not form coastal congregations during this period. The composition of the animals

encountered has also changed significantly. While harbour seals predominated in the coastal congregations in summer, their numbers in the coastal zone decreased by one-half at the end of October, and the number of ringed seals exceeded 7000 on the ice forming there.

With the appearance of ice in the bays and gulfs, the ringed seal, harbour seal and later the bearded seal haul out on the ice and form large congregations. Therefore, Gizhiga Bay, Zabiyaka Bay and Babushkin Bay are the places where seals can be hunted from sealers at the end of October. As the ice spreads farther southward, the hunting zone shifts along the northwestern coast to the Shantar Isls. and Sakhalin Is.

The major hauling-out grounds of the Okhotsk coast are shown in the diagram below.



Distribution of the principal hauling-out grounds of the harbour seal in the Sea of Okhotsk

Together with the seals in the coastal areas not surveyed by us (Burkanov, 1986; Kuzin et al., 1984), we can say that the total abundance of the harbour seal at the coastal rookeries of the Sea of Okhotsk is 48,000—50,000.

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A study of the effect of the harbour seal on the abundance of the brood stock of pink salmon (*Oncorhynchus gorbuscha*) off the coast of Sakhalin Is.

by A.I. Makhnyr and A.S. Perlov (TINRO)

The Sakhalin coast with its numerous spawning rivers and abundant shelf zone is where we can always find earless and eared seals (Phocidae and Otariidae), particularly the harbour seal (*Ph. larga*), the numbers of which have been estimated at 10,000 head at hauling-out grounds and in the coastal zone during the summer (Kosygin et al., 1986). As we know, the harbour seal feeds on fish; during the migration of salmons, this species congregates in the estuaries of spawning rivers and in places where salmon nets have been set out.

In order to determine the salmon losses caused by the harbour seal, a behavioral study of this species was carried out in August—September 1987 in the southern part of Sakhalin Is. (Cape Yefstafiy), in the places where trap nets had been set out and in the estuaries of spawning rivers. The number of pink salmon injured by the harbour seal was determined in the catches. The stomach contents of the harvested seals were analyzed. At the same time, we conducted visual observations from a distance of 40 metres in the Yefstafyevka estuary to study how the salmon are injured by birds, and counted all the fish entering the river.

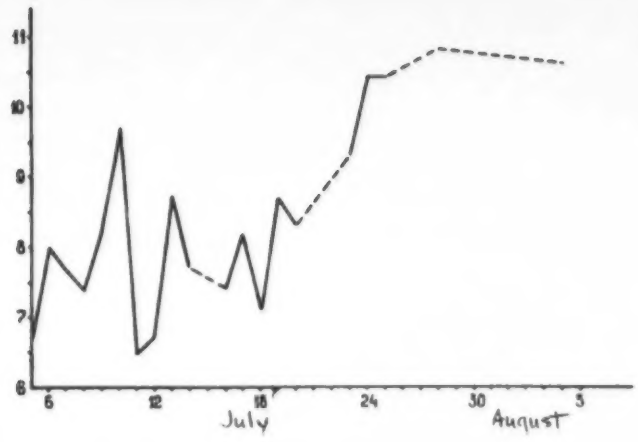
We examined 18,500 pink salmon from haul seines and trap nets for injuries. We found that 1558 (8.4%) of the salmons had been injured by the harbour seal, 1804 (9.8%) by the lamprey (*Lampetra japonica*), and up to 50% by carp lice (*Caligus clemensi* , *Lepeophtheirus salmonis* , *Salmonicola* sp.). The type of body injuries did not differ from that described earlier (Gritsenko, 1968; Chugunkov, 1970). We examined 710 fish carcasses to determine the causes of mortality in the brood stock of the pink salmon prior to spawning.

Deep wounds inflicted by the harbour seal (torn peritoneum, damaged internal organs, vertebral column, branchial apparatus, skull), which prevent the salmon from participating in the spawning process and eventually lead to death, were observed in 27.2% of all the injured individuals, or 2.3% of the salmons examined.

The stomachs of 17 harvested seals were examined to determine the quantitative and qualitative composition of the food consumed by them; food was found in six of them (35.5%). This was apparently due to the fact that the harbour seals had been caught with stationary net traps which kept them alive after entrapment, and since the animals were removed from the traps 2—3 days later, the food in their stomach had already had time to digest.

In the study area, the numbers of the harbour seal varied from 100 to 410. The percentage of pink salmon damaged by the harbour seal varied from 6.6% to 10.8% (see graph below). D.I. Chugunkov an coauthors (1984) claim that the harbour seal injures up to 18% of the brood stock of pink salmon, and this number increases with the scale of the salmon migration.

The analysis of the stomach contents of the harvested seals showed that pink salmon is the basic food of the harbour seal both in frequency and biomass during the period of salmon migration (table 1). Proceeding from the numbers of the harbour seal off Sakhalin Is. (10,000 head), the average weight of an individual (51.4 kg based on 17 seals, our data), the daily average rate of food consumption (7% of body mass, Spalding, 1964), the period of mass migration of the pink salmon (approximately 30 days) and data on the feeding of the harbour seal during this period (see table 1), we managed to calculate the biomass of the food consumed by the harbour seal during this period (table 2).



Changes in the number of pink salmon injured by the harbour seal

Table 1. Stomach contents of harbour seals caught on Cape Yefstafyevo, Sakhalin Is. in August—September 1987

Food item	Frequency of occurrence No.	%	Grams in one stomach	Food biomass, %	l i m (gr)
O. gorbuscha	5	83.3	1237.5	79.8	Trace-2000
Leuciscus br.	2	33.3	150	4.8	100-800
Myoxocephalus sp.	2	33.3	150	4.8	Trace-900
Salvelinus leuc.	2	33.3	250	8.1	200-1300
Pleuronectidae	2	33.3	Trace	Trace	Trace
Crab	1	16.7	50	2.5	300

During the mass migration of pink salmon on Sakhalin Is., the harbour seal consumes 11,300 centners of food, the bulk of this being pink salmon, kundzha (*Salvelinus leucomaenis*) and redfin (*Leuciscus brandti*) (see table 2). Naturally, this is an approximate figure, since the intensity of migration of the pink salmon and the numbers of the harbour seal differ from one part of the coast to the next. According to Yu.A. Bukhtiyarov (1984), fishes of the salmon family (*Salvelinus malma* and *Salvelinus leucomaenis*) constituted only 4.5% of the food consumed by the harbour

seal in Taun Bay in July—August, and 13.3% off the coast of the Kamchatka Peninsula in September—October.

Table 2. Biomass of the food consumed by the harbour seal off the coast of Sakhalin Is. during the mass migration of pink salmon

Food items	Biomass (thou.)
O. gorbuscha	9.1
Leuciscus brandti	0.5
Myoxocephalus sp.	0.5
Salvelinus leucomaenis	0.9
Crab	0.3
Total	11.3

If we consider the fact that the stocks of spawning pink salmon in the Sakhalin area during the odd-numbered years amount to approximately 300,000 centners and the harbour seal consumes 9100 centners by TINRO estimates, the losses here amount to about 3%; another 2.3% of the pink salmon stocks is destroyed as a result of the injuries inflicted by the harbour seal. The total pink salmon losses caused by the harbour seal on Sakhalin Is. amount to 5—5.3% of the pink salmon stocks.

However, the harbour seal is not the only, and possibly not the main factor responsible for the decrease in the abundance of pink salmon off the shores of Sakhalin Is. An important factor is the damage caused by the lamprey, especially if we take into consideration that salmons are the principal hosts of the parasitic lampreys (Abakumov, 1960). When there is an abundant generation of pink salmon (as in the year our investigation was conducted), the number of pink salmon infested by lampreys reaches 33% in the Sakhalin area, and 44% in the Amur area (Birman, 1950). The lamprey's attack on the pink salmon apparently takes place in the open sea (Soldatov, 1934), true, not for the purpose of parasitizing it as some maintain, but in order to speed up its own migration, though other researchers believe that the attack takes place closer to shore (Birman, 1950). In the majority of cases, the inflicted scars themselves do not kill the fish, but when the latter go into fresh water, a fungous disease

(*Saprolegnia*) develops at the sites of the lesions, which kills off a part of the brood stock (table 3).

Another indirect factor responsible for the decrease in pink salmon numbers is the carp louse which affects up to 50—60% of the fish in the coastal zone (Smirnova, 1971). The main sites attacked by the parasites (up to 20—50 per fish) are the bases of the pectoral and ventral fins, and the caudal peduncle; in fresh water, *Saprolegnia* develops at the site of the lesions.

Though not many (only 2.1%) of the pink salmon die as a result of lamprey and carp louse infestation (see table 3), the losses increase significantly (to 8.7%) with *Saprolegnia* .

Another factor responsible for the decrease in pink salmon numbers is predation by birds, primarily the herring gull (*Larus argentatus*), the slaty-backed gull (*L. schistisagus*), and ravens (*Corvus macrorhynchus* , *C. corax*). During low tide, when the mouth of a river becomes more shallow, the number of lesions increases to nearly 23%, i.e almost triples in comparison with the number of lesions during high tide (table 4). The localization of the injuries inflicted by birds is strictly differentiated; the gulls usually gouge out the eyes, but some of the injured fish are still able to reach the spawning grounds and spawn; the ravens, on the other hand, peck at the skull of the fish, and the latter die as a result.

Consequently, we have found that the part played by the harbour seal in reducing the numbers of spawning pink salmon is by far not the decisive one, resulting in losses slightly greater than 5% of the total number of spawners destroyed. A slightly greater numer of spawning pink salmon (about 9%) is destroyed by ectoparasites, and the largest number (over 21%) is destroyed by birds; in addition, the latter cause lesions in up to 23% of the salmon that manage to survive. The total losses due to the above biotic factors exceed 26%.

Naturally, the fish weakened by injuries, diseases and parasites are the first to fall prey to the harbour seal and, especially, birds; therefore, with these biotic factors overlapping each other, it is impossible to determine exactly the magnitude of the losses from each of them.

Table 3. Factors responsible for the losses in the pink salmon brood stock prior to spawning (Sakhalin Is., Yefstafyevka R., August—September 1987)

Month	Injured by harbour seal						Injured by lamprey						Injured by carp louse					
	1		2		3		1		2		3		1		2		3	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
August	17	3.6	49	10.4	66	14.0	6	1.3	15	3.2	21	4.5	4	0.9	13	2.7	17	3.6
September	8	3.3	27	11.3	35	14.6	2	0.8	10	4.2	12	5.0	3	1.2	9	3.8	12	5.0
Total:	25	3.5	76	10.7	101	14.2	8	1.1	25	3.5	33	4.6	7	1.0	22	3.1	29	4.1

(table 3 continued)

Month	Injured by birds						Injured by fishing nets						Cause unknown		Total examined	
	1		2		3		1		2		3					
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
August	68	14.4	28	6.0	96	20.4	14	3	47	10	61	13	109	44.5	470	100
September	39	16.2	12	5.0	51	21.2	5	2.1	21	8.7	26	10.8	104	43.4	240	100
Total:	107	15.1	40	5.6	147	20.7	19	2.7	68	9.6	87	12.3	313	44.1	710	100

N o t e : 1 - without *Saprolegnia* , 2 - with *Saprolegnia* , 3 - total

Table 4. Damage inflicted on the brood stock of pink salmon by birds, based on the results of visual observations (Sakhalin Is., Yefstavyevka Is., August—September 1987

Month	High tide								Low tide							
	1		2		3		4		1		2		3		4	
	No.	%	No.	%	No.	%	No	%	No.	%	No.	%	No.	%	No.	%
August	1700	100	84	4.9	33	1.9	117	6.8	950	100	186	19.6	28	2.9	214	22.5
September	800	100	41	5.1	15	1.9	56	7.0	330	100	58	17.6	17	5.2	110	22.8
Total:	2500	100	125	5	48	1.9	173	6.9	1280	100	244	19.1	45	3.5	324	22.6

Month	Total							
	1		2		3		4	
	No.	%	No.	%	No.	%	No	%
August	2650	100	270	10.2	61	2.3	331	12.5
September	1130	100	99	8.9	32	2.9	131	11.8
Total:	3780	100	369	9.8	93	2.5	462	12.3

Note: 1 - number entering, 2 - number injured by gulls, 3 - by ravens, 4 - total

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Data on the distribution and abundance of the harbour seal in Peter the Great Gulf

by A.M. Trukhin and G.M. Kosygin (TINRO)

The harbour seal of Peter the Great Gulf, which had been studied so intently during the 1960s, has dropped from the view of marine theriologists these past two decades. The investigations conducted a quarter of a century ago gave us some idea of the distribution of seals in the gulf; the abundance of seals was determined, samples of their food were taken, and the distinctive morphological characters of these animals were established. The harbour seal of Peter the Great Gulf was distinguished as an independent, separate population (Kosygin, Tikhomirov, 1970). Over the past two decades, significant changes have taken place in the gulf, mainly changes of an anthropogenic nature, namely an increase in navigation and the organization of the Far Eastern Sea Reserve. Consequently, it has become necessary to determine how this has affected the harbour seal population. Interest in the Sea of Japan harbour seal has been renewed also because of the appearance of Primorye's first salmon hatchery on the bank of the Amur R., which has made it necessary to determine the scale of the potential threat to this fishery on the part of the harbour seal (Lun, 1936; Freiman, 1936; Tikhomirov, 1961; Chugunkov, 1970; Chugunkov et al., 1984; Kosygin et al., 1986).

To study the present status of the harbour seal population, we conducted investigations in Peter the Great Gulf in 1985—1987. Some of the data on the distribution of this species at hauling-out grounds during the ice-free period was gathered by us over the period from 1979 to 1984, and some data was contributed to our study by I.O. Katin of the Far Eastern Reserve.

In 1985, data was gathered from the "Helios" lifeboats from February 20 to March 1, and from the "Vodolaz Terekhov" on March 23. Aerial surveys were carried out from a KA-26 helicopter. The same helicopter was used in 1986 to study the distribution and abundance of seals on the ice of the gulf. The area of the gulf from Posyet Bay south to Cape

Povorotnyi, located 20 km from the town of Nakhodka on the eastern coast, was surveyed. Aerial surveys were conducted in January—March. In April 1987, a single aerial survey was conducted in the northern part of the Amur Gulf.

The distribution of seals in the gulf during the ice period is largely determined by the ice conditions, mainly ice distribution, both during the different years, and during the individual months. In 1985, for example, which was a year of severe ice conditions, the seals were distributed comparatively extensively on the outgoing ice (Fig. 1). On the other hand, the areas of distribution of the harbour seal in 1986, as in 1969, were confined mainly to the Amur Gulf (Fig. 2).

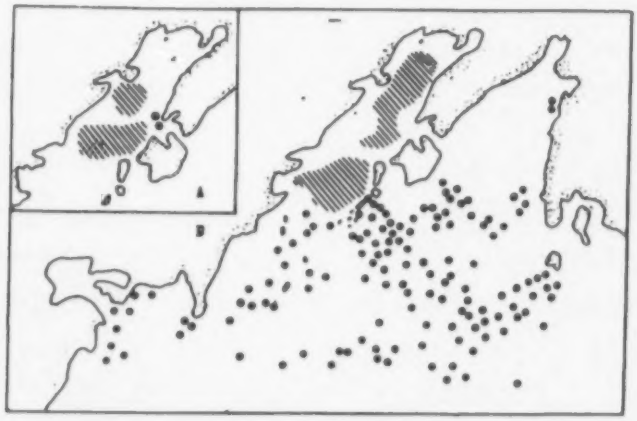

Fig. 1. Distribution of the harbour seal in Peter the Great Gulf from 23 February to 1 March 1985 (B) and in the Amur Gulf on 23 March 1985 (A)
\\\\\\\ - areas of seal concentrations, ● - solitary seals and small groups

We did not encounter a single seal when flying over Peter the Great Gulf in January. However, numerous holes (both fresh and frozen over ones) were observed in the coastal zone in a number of areas (Lomonosov Peninsula and Rimsky-Korsakov Is.). Judging by this, the seals prefer to stay in the water during this period, due to low air temperatures and comparatively strong winds. A similar picture was observed in winter, and primarily in other parts of the range of this species (Kosygin et al., 1984. No seal holes were observed in the Amur Gulf, which was completely covered with ice in January. At the same time, prior to the breakup of the

ice cover, the majority of the holes was confined to the boundary of fast ice and gray ice, which extended from the Lomonosov Peninsula in the west to the Popov and Reineke islands in the east.

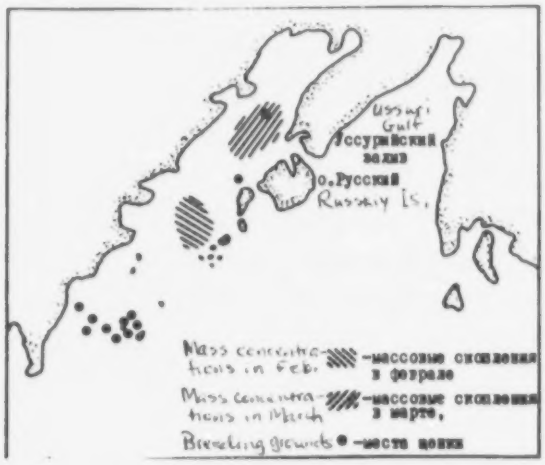
Ussuri Gulf
Уссурийский залив
о. Русский
Russkiy Is.
Mass concentrations in Feb. —массовые скопления в феврале
Mass concentrations in March —массовые скопления в марте,
Breeding grounds —места ловли

Fig. 2. Distribution of the harbour seal in Peter the Great Gulf in 1986

In February—March 1969 and 1985—1987, the principal area of congregation of the harbour seal in the Amur Gulf lay between Cape Peschanyi and Stolovaya Sopka (Fig. 2). On 23 March 1985, 230 harbour seals were counted at a rookery consisting of 3 groups of seals. As the ice broke up, the animals followed the ice edge deep into the Amur Gulf, hauling out on dense small floes of white ice. In February, the boundary of the fast ice and broken ice extends approximately at the latitude of Rikord Is., and in March at the latitude of Cape Peschanyi. At this time, the animals are distributed very densely on the ice, several tens on a single ice floe. These rookeries are apparently formed by moulting animals which remain there up to the middle of April. On 12 April 1985, for example, three large harbour seal rookeries located not far from each other were observed between Rechnoy Is. (Vtoraya Kovrizhka) and Skrebtsov Is. (Pervaya Kovrizhka). On 11 April 1986, we did not see any harbour seals on the last disappearing ice floes during our flight over the northernmost part of the Amur Gulf. In 1987, however, more than 120 harbour seals were observed in the same place during this period.

With the disappearance of the ice cover in the gulf, the animals migrate to their summer—autumn habitats, the islands of Peter the Great

Gulf; some of the animals probably migrate along the southern and eastern shores of the gulf.

Our data on the coastal rookeries of the harbour seal during the ice-free period are extremely fragmentary, while the literature concerning this question is limited to one mention of a harbour seal rookery in Posyet Bay (Kosygin, Tikhomirov, 1970).

During the summer—autumn period, the harbour seal is widely distributed in Peter the Great Gulf. The seals visit nearly all the islands in the gulf, but they form permanent hauling-out grounds only on some of them. The harbour seal is also systematically noted along the coast of the mainland, but because it is frequently disturbed by man, it very rarely hauls out on the shore, and does not form permanent rookeries anywhere.

On the basis of our material, we have established that coastal rookeries of the harbour seal definitely do exist in the following places:

1. Khalerpe Is. in Melkovodnaya Bay. Approximately 40 harbour seals were encountered at the end of summer—beginning of autumn 1984 on rocks in the coastal zone of the island during low tide.

2. Ryazanovka estuary. Harbour seals (numbers unknown) are encountered here on a regular basis throughout the summer—autumn period, but they do not form a permanent rookery.

3. Stenin Is. (Rimsky-Korsakov archipelago). Approximately 50 seals were observed in July—August 1979—1980 at the eastern end of the island. In the years that followed, up to 25 harbour seals have been noted here annually.

4. Matveyev Is. (Rimsky-Korsakov archipelago) and the kekurs and reefs adjacent to it. Approximately 70 harbour seals were noted here during the summer of 1979—1980. The numbers increased to 180 head in the 1980s.

5. Kamni Astafyeva (Astafyev Rocks). Up to 10—15 harbour seals haul out on the reefs in summer.

6. Kekury Baklanyi (Baklanya kekurs) off Cape Lev. From 20 to 60 seals haul out here.

7. Furuhelm Isls. Individual harbour seals are noted on the islands during the summer period; a permanent rookery is not formed.

8. Kamni Mikhelsona (Michaelson Rocks) between the Furuhelm Isls. and the mainland. There is no permanent rookery here; individual animals haul out during the summer and early autumn.

9. Kamni Butakova (Butakov Rocks). Up to 120 harbour seals form a rookery here in summer.

10. Falshivyi Is. Individual seals periodically haul out on the reefs near the island in summer.

Individual harbour seals or small groups are sometimes observed on the Zheltukhin, Reineke, Rikord and Bolshoi Pelis islands, and on the Kim, Ir and Sena kekurs.

Abundance. In 1968, 138 harbour seals were encountered in Peter the Great Gulf over a 20-day observation period, and the total numbers of this species have been estimated at several hundred (Kosygin, Tikhomirov, 1970). Over a period of two decades, the numbers of the harbour seal in this area have just about doubled, as the following data will show. During the first ten days of April 1985, a survey from a helicopter showed that there were about 700 harbour seals in the Amur Gulf alone, and 500 were counted between Rechnoy Is. and Skrebtsov Is. during the second ten days of April. During aerial surveys in 1986, up to 500 animals were counted in a single day. At the time of the surveys, some of the animals were in other parts of Peter the Great Gulf, and were left uncounted. There must be at least 1000 harbour seals in the population at the present time.

It has been noted that as the density of the ice decreases in the gulf from February to April, the density of the rookeries increases, and the numbers of the harbour seal increase considerably, peaking during the last days of March.

The harbour seal of Peter the Great Gulf begins to give birth sooner than the harbour seal of the more northerly parts of the range, i.e. in the middle of February with the peak in the second half of the month (Kosygin, Tikhomirov, 1970). From 20 February to 1 March 1985, we counted 16 white-coats from 1 to 10—15 days of age from our vessel. They all had the ash-coloured coat characteristic of the population of this gulf.

During the third 10-day period of February 1986, we attempted to locate the breeding grounds of the harbour seal. It should be said that newborn harbour seals were very rarely observed during the period of

our surveys, not more than 3—5 per flight. Nevertheless, we did manage to locate the principal breeding ground. We noted white-coats more or less regularly in the vicinity of the Rimsky-Korsakov Isls., and less commonly on ice cakes on the Cape Peschanyi traverse in the northern part of the Amur Gulf (Fig. 1, B). It is interesting to note that the harbour seals bore their pups on pack ice cakes in the second case, and on ice cakes and fast ice 10—20 m from the shore near the islands.

Individual harbour seal pups were observed in the vicinity of Matveyev Is. in March; one white-coat was noted on the ice near Popov Is. The breeding period lasted up to the middle of March. An entirely fresh birth spot was noted on the Cape Peschanyi traverse on March 11th. At the same time, dense harbour seal rookeries numbering up to 100 animals were observed in the same place.

The listed surveys and a study of the nature and direction of the ice drift in Peter the Great Gulf give grounds for assuming that the current carries the female seals and their newborn pups out of the Amur Gulf away from the Rimsky-Korsakov Isls. with the pack ice southward and southeastward. Consequently, seal pups are not frequently encountered in the Amur Gulf and in the vicinity of the islands. The pups complete their moulting outside the Amur Gulf, on melting ice cakes. One can assume that many of these pups perish during a storm. A moulted white-coat was observed only once (March 6) on fast ice near Matveyev Is. It no longer had any embryonic fluff on its back. According to earlier data (Kosygin, Tikhomirov, 1970), the seals encountered in Peter the Great Gulf consisted mainly of adult animals. In the photographs taken from a helicopter in 1986, large animals predominated in the groups. Not once did we observe moulted underyearlings on the ice.

During our surveys from the "Helios" and "Vodolaz Terekhov" vessels, we approached the rookeries at a distance of up to 50—70 m, and not a single animal went back into the water. The harbour seals remained just as calm when we flew over them in a helicopter at an altitude of 50—70 m. Many of the seals remained on the ice when the helicopter flew at 20 m. We flew as close as 7 m to one harbour seal lying on the ice. This kind of behavior is not typical of other populations of the harbour seal. One can assume that this loss of precaution in the harbour seal of Peter the Great

Gulf is is due to the fact that this population has lived in a densely populated area for a long time and has not been threatened by man.

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Walrus hauling-out grounds on the Kamchatka Peninsula

by A.R. Semenov, V.N. Burkanov and S.A. Mashagin (Kamchatrybvod)

We have been conducting regular aerovisual and boat surveys of the northeastern coast of Kamchatka since 1982 (2—3 times a year). The aerovisual surveys have been carried out from the AN-2 and Yak-40 airplanes and the MI-8 helicopter, and the boat surveys from medium freezer-trawlers and different types of motor boats. Continuous observations at walrus rookeries were begun in 1985. In 1985, observations of this type were conducted on Verkhoturov Is. in July—August, and on Cape Golenishchev of Karaginski Is. in August; in 1986, they were conducted on Verkhoturov Is. (August—beginning of September), Cape Golenishchev (August and October) and Cape Semenov (July, August, October) on Karaginski Is. In 1987, continuous observations were conducted at the Cape Semenov rookeries on Karaginski Is. (October), on Verkhoturov Is. (August—beginning of September), Cape Galinvilan in Korf Bay (August—beginning of September), on Bogoslov Is. (August—beginning of September) and in Anastasia Bay (September).

During the aerovisual, boat and permanent observations, we also recorded the walrus carcasses found on the shore, examined the dead animals, and took teeth samples for age determination.

We currently know of six walrus rookeries on the Kamchatka Peninsula; walruses can be found at these rookeries throughout the ice-free period. They are located on Verkhoturov Is. (59°35' N lat), on Cape Galinvilan in Korf Bay (60°00' N lat), on Cape Seryi in the Okhotsk Gulf (60°10' N lat), on Bogoslov Is. (61°06' N lat), in Anastasia Bay (61°20' N lat) and Dezhnev Bay (61°40' N lat) (see Fig. 1). We know of another four rookeries where walruses haul out either erratically but repeatedly during the ice-free period, or only during certain months (seasons) of the year. These rookeries are found on Cape Semenov (59°00 N lat) and Cape Golenishchev (59°15' N lat) on Karaginski Is., in Somneniye Bay of the Olyutorski Gulf (60°30' N lat) and on Cape Olyutorski (59°55' N lat). Some of the rookeries on the peninsula are not formed every year, and walruses do not usually stay there very long. Rookeries of this type have been

noted in the Srednyaya Lagoon of the Olyutorski Gulf (61°23' N. lat) in June 1984/85, on the Olyutorski sand bar in Korf Bay (60°22' N. lat) in autumn 1987, in the bay Nerpichye Ozero (60°20' N. lat) in summer and autumn 1985, on the Burunnykh Isls. (60°40' N. lat) in June 1984, and on the Vasiliy Isls (61°15' N. lat) in June 1987.

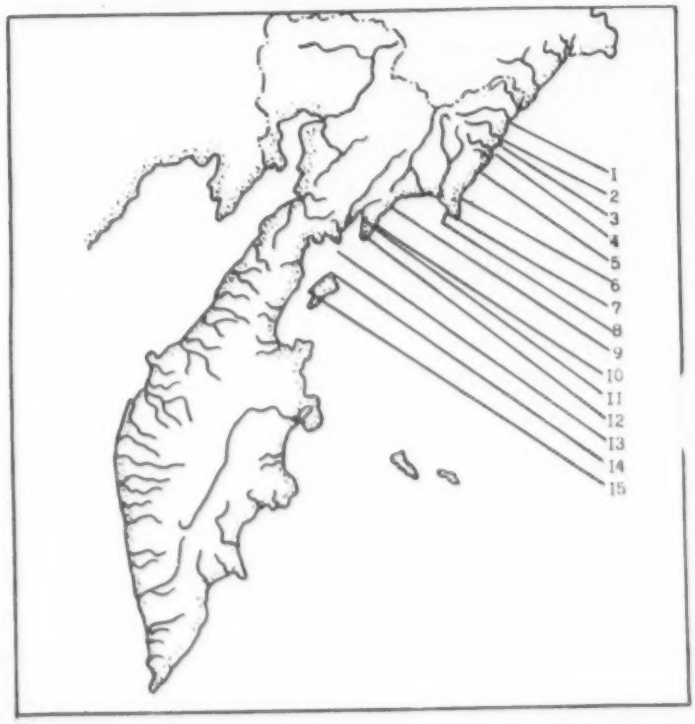

Fig. 1. Walrus hauling-out grounds on the Kamchatka Peninsula: 1 - Dezhnev Bay, 2 - Anastasia Bay, 3 - Vasiliy Is., 4 - Bogoslov Is., 5 - Brunnykh Is.., 6 - Nerpichye ozero, 7 - Cape Olyutorski, 8 - Vodopadnoye, 9 - Somneniye Bay, 10 - Srednyaya Lagoon, 11 - Olyutorski sand bar, 12 - Cape Galinvilan, 13 - Verkhoturov Is., 14 - Cape Golenishchev, 15 - Cape Semenov on Karaginski Is.

In 1984, four adult walruses hauled out on Manchzhur Is. in the southern part of the Karaginski Gulf throughout the summer.

We also noted individual walruses hauling out on the Commander Isls. and on the Kronotsky Peninsula.

Rookery on Verkhoturov Is. This rookery is located in the northwestern part of the island. Over the past four years, up to 5000—6000 walruses have been hauling out here, though these numbers may vary significantly from month to month. This rookery beings to function after the ice breaks up in the Karaginski Gulf (May, June). The walruses haul out here with a clearly defined cyclicity (Fig. 2), which lies in their systematic and total departure from the island to forage. This rookery functions continuously throughout the summer and autumn.

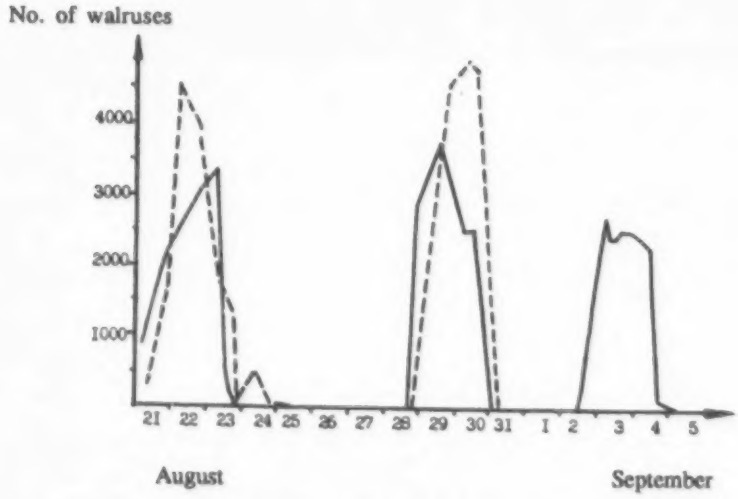

Fig. 2. Dynamics of walrus abundance at the rookeries of Cape Galinvilan (unbroken line) and Verkhoturov Is. (dashed line) from 21 August to 4 September 1987 (rookeries 80 km away from each other)

Rookery on Cape Semenov, Karaginski Is. This is the southernmost walrus rookery recorded on the Far Eastern coast of the USSR. In 1982, up to 2000 walruses were regularly observed at this rookery. During 1984—1987, walruses made rare appearances here, not more than once in 1—3 months, predominantly in autumn. According to Inspector Ye.V. Kitayev,

up to 2000 walruses hauled out here from 7 October to mid December 1987, i.e. for more than 2 months.

Rookery on Cape Galinvilan in Korf Bay. This rookery is located in the southeastern part of Korf Bay. Approximately 1500—2000 walruses usually haul out here; however, in August 1987, the walrus numbers at this rookery peaked at about 3700 head (see Fig. 2). It is interesting to note that a comparison of the dynamics of walrus abundance at the rookeries of Cape Galinvilan and Verkhoturov Is. (80 km apart) in August 1987 showed that they were remarkably synchronous (see Fig. 2). As on Verkhoturov Is., the walruses at the Galinvilan rookery haul out in summer with a periodicity of 6—8 days. This rookery functions continuously during the summer—autumn period.

Rookery in Somneniye Bay. As a rule, this rookery functions in June. Walruses are not noted here after that. The walrus numbers do not exceed 2000.

Vodopadnoye rookery. It is located in the eastern part of the Olyutorski Gulf. Walruses haul out at any point along the coast from Cape Seryi to Cape Anan (sometimes at several points simultaneously). The maximum abundance of walruses hauling out here does not exceed 4000. This rookery functions continuously throughout the summer.

Rookery on Cape Olyutorski. This rookery is characterized by the fact that it is formed only in autumn. The maximum abundance of walruses noted here is 3500.

Rookery on Bogoslov Is. During the summer—autumn period, this rookery functions continuously, with a characteristic cyclicity. The walrus numbers in June can reach 3000, but later drop to 400—600 head.

Rookery in Anastasia Bay. It functions continuously throughout the ice-free period. Permanent observations at the rookery in September 1987 showed that there was no clearly defined cyclicity in the dynamics of walrus abundance, as was observed at the southern permament rookeries. The walrus numbers at this rookery can reach 800, but do not usually exceed 400—600 head.

Rookery in Dezhnev Bay. The highest number of walruses observed at this rookery is 700—800 head, but we have noted traces of a greater number hauling out here several times.

The Kamchatka walruses apparently spend the winter in the Khatyrka—Navarin area. Despite our search, we have not seen any walruses overwintering in the Korf—Karaginski and Olyutorski gulfs. With the ice drift, some of the walruses migrate southward in March; in April, they reach the Karaginski Gulf where they are observed on the ice at this time right up to Cape Ozernyi in the south. With the breakup of the ice, the walruses haul out at the coastal rookeries. However, the walrus numbers in the Karaginski and Olyutorski gulfs at this time are still far from the highest. An increase in the walrus numbers at the northern Kamchatka rookeries is observed in June. At the end of June and in July, the animals migrate southward. During this period, they may form rookeries on the Burunnykh Isls., in Nerpichye Ozero, and in other unexpected places. The walrus numbers at the Kamchatka hauling-out grounds stabilize at the end of July—August. The autumn migrations of walruses apparently commence at the beginning of September and last up to the middle of the month; it is at this time that the rookery on Cape Olyutorski begins to function. The migration of walruses spreads out over a long period of time. The remaining animals depart from the summer hauling-out grounds in November—December.

Only male walruses have been noted at the Kamchatka rookeries. As shown by our age surveys based on the VNIRO method (comparison of the exterior characteristics of the animals with the standard table of exteriors of different age groups) and the results of the age determination of the dead walruses found in Kamchatka, three-year-olds and older walruses haul out on this peninsula (Fig. 3), a significant number of the animals (from 45.6% to 66.7%) being over 15 years of age; however, the percentage of animals in the 10—15 year age group (animals at the peak of their reproductive capacity) is also significant (from 26.6% to 47.6%). It is interesting to note that the age of the animals that died in the autumn of 1984 in Nerpichye Ozero (exact cause of the simultaneous death of about 80 animals has not been established) was significantly younger than in other cases (see table and Fig. 3).

Age composition of walruses that died in Nerpichye ozero in the autumn of 1984

Age	Number	Age	Number	Age	Number
9	1	14	2	20	2
10	1	15	3	21	1
11	2	16	4	23	1
12	2	19	1	26	1

In our opinion, a herd of walruses migrating north to the breeding grounds of the Pacific subspecies of the population had died here. Therefore, we believe that a significant part (perhaps more than 50%) of the Kamchatka grouping of walruses participates in the breeding process, as evidenced by the dual nature of the spring migration, the age structure of the walruses at the hauling-out grounds, and other circumstantial facts. After participating in the breeding process, a certain part of the Kamchatka herd apparently overwinters in the vicinity of the Anadyr Gulf, migrating southward and reaching the northern Kamchatka hauling-out grounds in June.

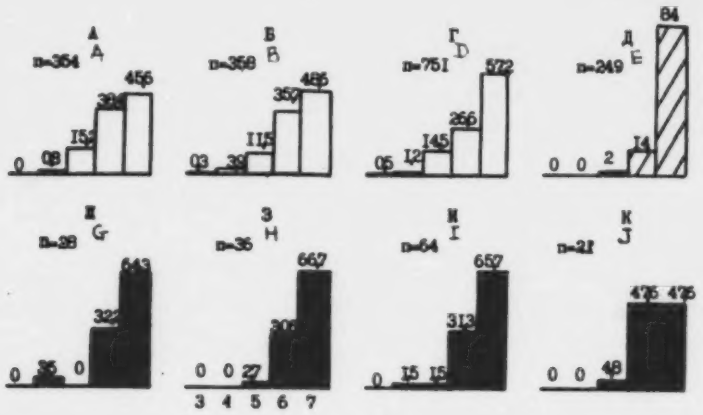

Fig. 3. Results of walrus surveys (%) at hauling-out grounds by age groups (VNIRO method)

A - in August—September 1985 on Verkhoturov Is, B - in August—September 1986 on Verkhoturov Is., D - in August—September 1987 on Bogoslov Is., E - age structure of walruses (by groups) harvested in spring 1984 in the Khatyrka—Navarin area (Kibalchich, 1985). Age structure of dead walruses (by groups) found in 1986—1987, G - in Karaginski Gulf, H - from Cape Olyutorski to Dezhnev Bay, I - Sredneye, J - in Nerpichye Ozero (1984), 3rd group - 3 years, 4th group - 4—5 years, 5th group - 6—9 years, 6th group - 10—15 years, 7th group - 15 years

On the basis of a comparison of walrus abundance at the Verkhoturov rookery at the beginning of June (about 2000 walruses) and at the end of August (up to 6000), one can hypothesize that two-thirds of the Kamchatka walruses participate in the breeding process. The rest of the animals overwinter in the Khatyrka—Navarin area, gradually moving southward with the ice drift. It is these walruses that become part of the experimental harvest, though the effect of selectivity is not excluded (see A.A. Kibalchich. Age and sexual structure. Areas of walrus hunting and the reproductive condition of the Pacific walrus. IN: Conducting Surveys of the Pacific Walrus. Moscow: VNIRO, 1985, p. 27—43).

Migrations of the Pacific walrus and the dynamics of its abundance at hauling-out grounds

by N.I. Mymrin, G.P. Smirnov, A.S. Gayevsky, A.I. Grachev
Yu. V. Klimenko (Okhotskrybvod)

This study is based on our own observations of 1983—1985, hydrological data on the ice surveys of the Pevek Hydrometeorologic Administration, as well as data from the literature.

Migrations. Many researchers mention the seasonal habitats of the walrus, and, therefore, the migrations of these animals northward (from the Bering Sea to the Chukchi Sea) in spring, and southward in autumn (Nikulin, 1940; Krylov, 1968; Fedoseyev, Goltsev, 1975; Fedoseyev, 1984). Using the results of aerial surveys, S.Ye. Belikova, Yu.A. Gorbunova and V.I. Shilnikova (1984) conducted a detailed study of the northward migration of walruses by month for 1971—1979.

Based on the ice surveys for 1984—1985, walruses were noted in the open sea in the area between St. Lawrence Is. (USA) and the Bering Strait in February, March and April. Twenty walruses were noted here in February 1985, 51 walruses in March, and one walrus in April. As we know, the main walrus groups are found much farther south during these

months, i.e. at 57°—62° N. lat, in the vicinity of the southern ice edge (Fedoseyev, 1982). At the end of March—April, large congregations of walruses were noted simultaneously in the Anadyr Gulf and north of St. Lawrence Is. In April 1984, 7 groups and more than 1500 walruses were spotted in the Anadyr Gulf from aircraft. At the same time, 5 groups and 320 walruses were seen south of the Bering Strait. Eleven walruses were encountered much farther north of the Bering Strait, at 68° N. lat. At the same time, 3 groups and 51 walruses were noted in the open sea at 58° N. lat. 750 km southeast of Cape Navarin.

According to our observations, the migration of walruses in the Chukchi Sea continues in June, July and August. During these months, the animals continue to leave the rookeries of the Anadyr Gulf. The migration of walruses eastward has been noted by sea hunters in the coastal villages of southeastern Chukotka—Enmelene, Nunligrane and Sirenikakh.

Therefore, the "spring" migration northward extends over a time period of 5—6 months (from March—April to August) and a geographic distance of 1500—2000 km (this distance separated the northernmost and southernmost groups of walruses in April 1984). The largest congregations of walruses in the vicinity of the Bering Strait were observed in May—June (Belikov et al., 1984). According to the observations at the rookery on Arakamchechen Is. located 160 km south of the Bering Strait, the "autumn" migration begins during the third 10-day period of August. From 1983 to 1985, the approach of the walruses from the north was noted within a short span of time, from August 26th to August 31st. On 29 August 1977, the walruses approached from the north (Kibalchich, 1978). According to our observations, the approach of the walruses from the north took place on 26—28 August in 1983, on 27—28 August in 1984, and on 30—31 August in 1985. The 1985 observations in the Chukchi and Bering seas in the vicinity of the Bering Strait from vessels and helicopters showed that the mass migration of walruses from the north took place in October—November, and continued possibly in December. Large congregations of walruses were noted on the ice in the coastal zone from Cape Serdtse-Kamen to Cape Inchoun on 27—28 October (10,000—15,000 walruses counted); hundreds of walruses were noted in the Bering Strait from a helicopter from 31 Octrober to 7 November; from 2000 to 3000

walruses in two groups were spotted from a helicopter on young pancake ice southeast of the St. Lawrence Gulf on 21 November. These periods of migration coincide with the hydrologic data of ice surveys and the data of S.Ye. Belikov et al. (1984) on the Bering Strait area. The "autumn" migration in the Bering Strait area probably ends in the middle or at the end of December.

Therefore, the period of the "autumn" migration lasts for about five months. As a result, the Pacific walrus population spends about 10 months in migration; during this time, a large part of the population covers long distances. If we take the Bering Strait as a reference point, two waves of intensive migration of walruses are noted here annually, northward in spring (May—June) and southward in autumn (October—November). The organization of annual observations in the Bering Strait will enable us to verify the periods and intensity of the seasonal migrations of walruses. The migration of walruses to the Chukchi Sea for the summer is attributed by researchers to their strong attachment to the ice, especially the females and their pups (Fedoseyev, 1982). Our observations at hauling-out grounds in 1983—1985 and the observations of Kamchatrybvod inspectors (Pinigin, Pryanishnikov, 1975) have shown that in summer, with the disappearance of ice on the Bering Sea, a large number of walruses remains in the coastal zone and haul out at rookeries in the Karaginski Gulf off Kamchatka Peninsula, at rookeries in the Anadyr Gulf (Russkaya Koshka, Meyechkin sand bar, Redkin sand bar), and at rookeries in the vicinity of Bering Strait (Nuneangan Is., Arakamchechen Is.). The total number of walruses living here in summer (July—August) has been estimated at 50,000—60,000, 30,000—40,000 of these being females and their pups. In August 1985, females constituted about 68% of the total numbers at the Meyechkin rookery, and about 50% in August and about 80% in June at the Redkin rookery. At the rookery on Arakamchechen Is., the females and pups constituted from 0.2% to 1.0% of the total numbers at in 1984—1985. Female walruses predominated in the harvests of the hunting villages of the Anadyr Gulf. This points to the signficant quantitative and qualitative changes in the population of the Pacific walrus.

These observations have revealed the previously unknown capacity of walruses to form large permanent coastal rookeries at which females and their pups predominate. Permanent, temporary and sporadic walrus rookeries have been described in the literature (Goltsev, 1968). All this points to the fact that ice is not a compulsory factor in the life of walruses during the summer—autumn period. We assume that the Pacific walrus population could spend the entire year in the Bering Sea. All the conditions necessary for this exist there, namely vast shallow areas with depths up to 100 m in the northern and eastern part of the sea (the area of these shallow parts with an isobath limited to 100 metres covers approximately 600,000 km^2, which is about 1.5 times greater than the 100-metre-deep area of the Chukchi Sea. The distribution of walruses in the Chukchi Sea is restricted by the ice conditions). The shallow waters of the Bering Sea abound in feed for walruses, as well as islands and other places that are suitable as hauling-out grounds during the ice-free period, where the walruses, including the females and their pups, form their rookeries in summer. Nevertheless, a large part of the walrus population, which numbers over 300,000 at present, migrates annually to the Chukchi Sea. Seasonal migrations took place earlier, when the population consisted of only 50,000 individuals (Krylov, 1968). We believe that the seasonal migrations of the walrus can be explained by their origin. Ye.M. Anbinder (1978) believes that walruses similar to the present-day species found their way into the northern part of the Pacific Ocean via the Arctic Basin.

Dynamics of walrus abundance at hauling-out grounds. Observations at the rookeries of Arakamchechen, and the Redkin, Meyechkin and Russkaya Koshka sand bars (Fig. 1) during the summer—autumn months of 1983—1985 have shown that the walrus numbers at the rookeries change with a certain cyclicity. Twelve peaks of abundance were noted on Arakamchechen Is. from 1 July to 20 September 1983. The time interval between the peaks of abundance is from 3 to 8 days (5.77 days on the average). In 1984, the peak of abundance set in at intervals of 5.75 days on the average (observation period from July 14th to August 28th), and in 1985 every 5.70 days (observation period from July 12th to October 4th). These figures were 5.1 days and 6.0 days in 1984 and 1985 respectively

for the Redkin sand bar, 6.1 days in 1985 on the Meyechkin sand bar, and 7.6 days in 1985 on Russkaya Koshka.

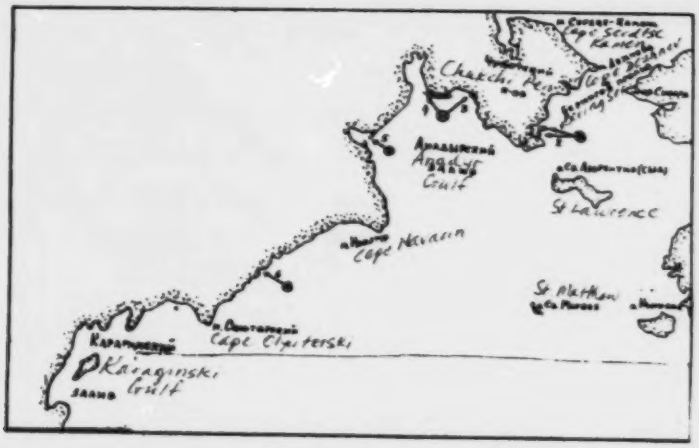

Fig. 1. Walrus rookeries in the Bering Sea in August—September 1985:

o - rookeries with females predominating;
● - male rookeries: 1 - Arakamchechen Is., 2 - Nunеangan Is., 3 - Redkin sand bar, 4 - Meyechkin sand bar, 5 - Russkaya Koshka, 6 - Bogoslov Is. in Natalia Bay

A particularly distinct rhythmicity of minimum and maximum walrus numbers rookeries was observed on Arakamchechen Is. in July—August. During this period, the peaks of abundance were noted every 5—6 days. The minimum walrus numbers at the rookery showed the same periodicity. Subsequently, the rhythm was greatly altered by storms. By comparing the graphs depicting the dynamics of walrus abundance at all four rookeries in 1985, we can see that they are generally identical at all four. Opposite phenomena were observed twice in August. The first time was from the 15th to the 20th of August, i.e. a mass approach reaching maximum numbers took place at the Arakamchechen, Redkin and Meyechkin rookeries, followed by the departure of the animals into the sea, while at the same time, the numbers decreased and then increased at the Russkaya Koshka rookery. The second arhythmic period occurred on August 21—25. i.e. the maximum number of animals appeared at the Arakamchechen and Russkaya Koshka rookeries, and the lowest number at the Meyechkin and Redkin rookeries. During the rest of the observation periods in July—September 1985, the walrus numbers at the four

rookeries fluctuated roughly in synchronism. Comparing the dynamics of walrus numbers at the four rookeries, we should take the following into account: 1) the great distance between the rookeries (Fig. 1); 2) the significant differences in the composition of the animals hauling out at these rookeries; 3) the highly significant differences in the local weather conditions. With these conditions in view, the synchronism of walrus activity in a vast area of water evokes an even greater interest (Fig. 2).

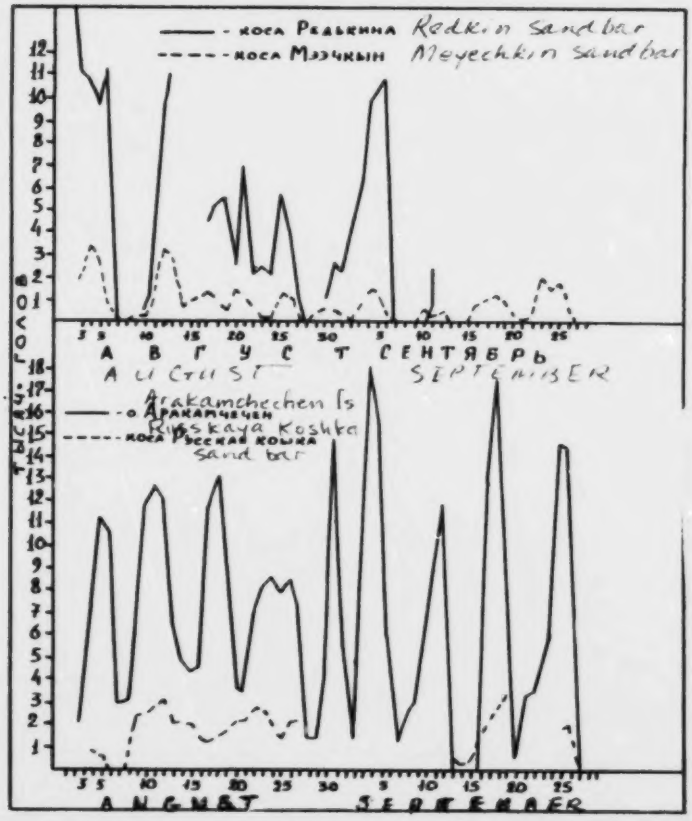

Fig. 2. Dynamics of walrus abundance at the rookeries of the Bering Sea in August—September 1985

Daily activity. In 1985, the surveys of walrus abundance at all four rookeries were carried out twice daily, in the morning and in the evening. Based on the example of the Arakamchechen rookery, we established that 64% of the peaks of walrus abundance at the rookery come in the evening, and 36% in the morning. Having divided the observations into two periods (the calm period from12 July to16 August, and the period of regular and intense storms from17 August to 30 September), we obtained a more

detailed picture [a sentence or two is missing in the Russian text; the missing sentence ends with the words ....38%, evening 62%. - transl.]. During the second period, the morning peaks of abundance amounted to 33%, and the evening ones to 67%. Therefore, regardless of the significant changes in weather conditions, the peaks of walrus anundance at the rookeries in two out of three cases come in the evening.

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Walrus rookery on the Russkaya Koshka sand bar

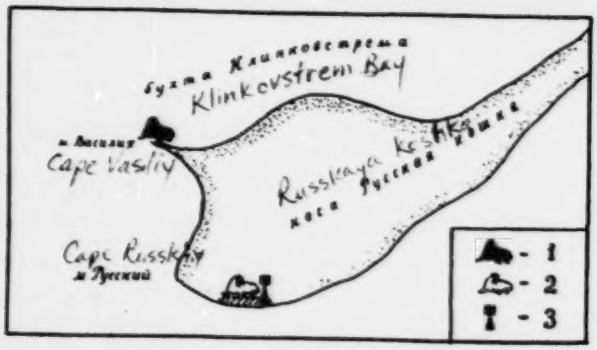
by G.P. Smirnov (Magadan, Okhotskrybvod)

As we know from the past literature, Russian explorers headed by S.I. Dezhnev discovered a walrus rookery in the Anadyr estuary in 1652. It was located on a small river bar [Russ. korga] which was later named Russkaya koshka. Dezhnev noted in 1655 that a good many walruses hauled out on the cape itself for half a verst or so (about half a kilometre) all around it from the side of the sea, and about 80—100 m inland, with a good many animals still in the water (after V.V. Leontyev, 1976). Over a period of four years (from 1652 to 1656), Dezhnev harvested 289 poods (about 4734 kg) of walrus tusks at the rookery.

After that, the walrus rookery on the Russkaya Koshka sand bar was not mentioned in the literature again (even as an extinct one). One can assume that the Russkaya Koshka rookery became extinct as a result of the predatory hunting of walruses in the second half of the 19th century. Indirect evidence of this are the communications of N.L. Gondatti (1897), K.I. Bogdanovich (1901), A.A. Prozorov (1902), and V.G. Bogoraz (1934) who wrote, among other things, that the Kereks were starving to death because walruses stopped approaching the shores south of Anadyr Bay.

In 1984, the walrus rookery on the Russkaya Koshka sand bar came to life again. According to the Russkaya Koshka lighthouse attendant, V. Maslov, the first walruses hauled out at the rookery at the beginning of July, and the last ones departed at the beginning of November, when the ice became strong enough. Whereas in Dezhnev's time the walruses occupied the tip of the Russkaya Koshka sand bar from the side of the sea, they were now forced to move three kilometres into the liman, onto the sandy—pebbly sand bar of Cape Vasiliy, due to the constuction of lighthouse facilities and houses for the attendants. Nevertheless, there are some cases of walruses hauling out on the territory of the old rookery 200—300 m southwest of the lighthouse in 1984 and 1985. However, the walruses did not usually stay there very long; frightened by the 24-hour noise of the diesel engine and various odours, the animals went back into

the water and then hauled out on Cape Vasiliy (see diagram of rookery below).



Russkaya Koshka rookery:

1 - present location of rookery, 2 - 17th century location,
3 - lighthouse and meteorological station

Abundance surveys and age—sex determination of the composition of the animals at the rookery were not carried out in 1984. We can only quote V. Maslov's estimate of 700 head where abundance is concerned.

In 1985, the walruses hauled out on the morning of July 1st. From this day up to October 3rd, the Anadyr sea mammal monitoring and observation station conducted permanent observations to study the dynamics of the rookery, its age and sexual composition, and ethology of the walrus. The age and sexual composition was determined visually on the basis of exterior characteristics and the size of the tusks (by the standard chart), and by analyzing material from dead walruses. This is a purely male rookery consisting 99% of sexually mature males with a few 2—5-year-old males among them. Under favourable conditions, the walrus numbers on the Russkaya Koshka sand bar exceeded 3000. Abundance was determined by the area of the rookery with the occupancy coefficient estimated by A.I. Grachev for the Arakamchechen rookery (1.13385) taken into account. The amplitudes of the 12-hour fluctuations in walrus numbers amounted to +1580 head and -1440 head. The average for the entire observation period was ±437 head.

Dynamics of walrus numbers at the rookery

Date	Numbers		Date	Numbers		Date	Numbers	
	am	pm		am	pm		am	pm
04.08	800	600	18.08	1140	1380	16.09	660	1220
05.08	500	300	19.08	770	1640	17.09	1960	?
06.08	nil	nil	20.08	1320	1970	18.09	2420	2610
07.08	nil	2	21.08	1830	2080	19.09	3120	?
08.08	300	445	22.08	1880	2730	25.09	1690	1760
09.08	1180	2410	23.08	2410	2700	26.09	1970	530
10.08	2180	2350	24.08	1950	820	27.09	620	nil
11.08	2200	2570	25.08	750	1450	28.09	nil	nil
12.08	3090	2410	26.08	2090	2060	29.09	nil	nil
13.08	2090	1910	27.08	2180	?	30.09	nil	nil
14.08	2040	1830	13.09	?	387	01.10	nil	nil
15.08	1970	320	14.09	72	104	02.10	1570	2360
16.08	290	1430	15.09	140	342	03.10	3090	?
17.08	1245	670						

Using the above-mentioned occupancy coefficient and Dezhnev's estimates, we established that the walrus numbers on the Russkaya Koshka sand bar in those days amounted to 30,000—35,000 head.

It should be said that the constant anthropogenic disturbance factors in the vicinity of Russkaya Koshka (round-the-clock operation of a diesel engine, a navigable channel nearby, etc.) apparently increase the dynamics of the rookery and prevent the formation of the latter at the original site. Proceeding from this, we consider it necessary to press for the automation of the Russkaya Koshka lighthouse and the inclusion of the territory of the rookery and the 12-mile zone around it to the territories protected by the USSR Ministry of Fisheries.

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Summer distribution of the walrus in the Anadyr Gulf

by A.I. Grachev (Okhotskrybvod)

The present paper contains data on the changes that have taken place in the structure of the Anadyr grouping of walruses over the past few years, data which differ from that presented in the literature (Krylov, 1966; Goltsev, 1968; Kibalchich, 1982; Krushinskaya, Lisitsina, 1983).

Our investigations were conducted during the 1982—1987 seasons at the walrus rookeries at Russkaya Koshka, Meyechkin, Rudder, Konergino, Enmelen and Nunlingran, and from a patrol vessel.

The biological material was collected and processed by the standard methods. Yu.V. Klimenko, N.I. Mymrin, G.P. Smirnov and A.G. Somov assisted with the collection of the material.

Dynamics of abundance. The distribution of the walrus on the ice in the Anadyr Gulf was observed by us in May—June 1982 and 1986. The principal walrus congregations in May were noted in the central part of the gulf and on the Cape Navarin traverse. In June, the walrus was distributed along the edge of the ice mass on the gulf coast. A congregation of walruses was noted on the Anadyr estuary traverse, where up to 200—500 walruses were counted daily at each of the dozens of rookeries during the last ten days of June. The second congregation of walruses was observed in the northern part of the gulf, where approximately 1500 animals were counted on 13 June 1982.

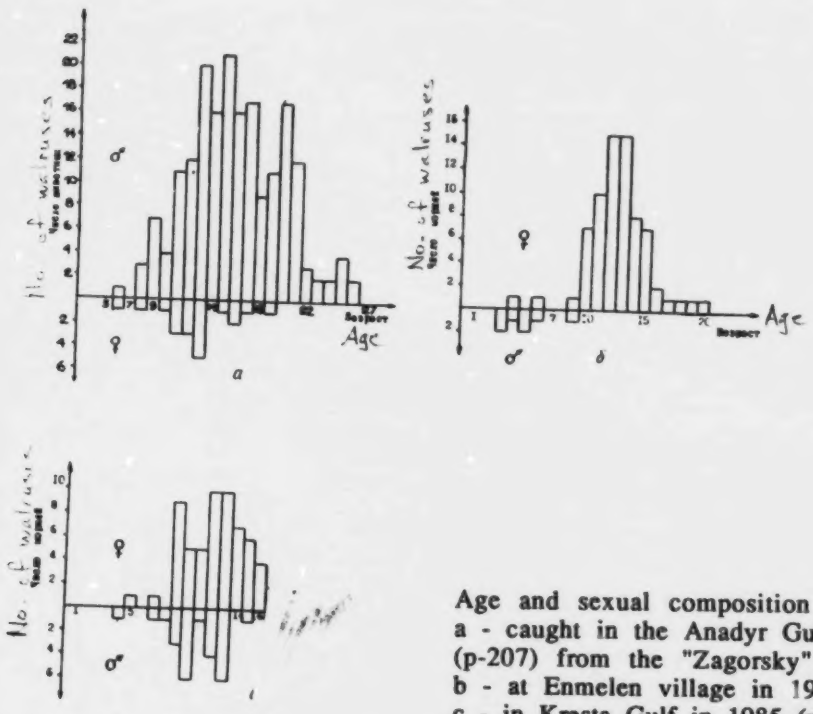
The rookeries at the Rudder and Meyechkin hauling-out grounds begin to form at the end of June—beginning of July, from the moment the ice breaks up in the Anadyr Gulf. The maximum walrus numbers at the rookeries were recorded at the time the hauling-out grounds first began to

function. At the Rudder rookery, 24,000 walruses were noted on 1 July 1983, and 59,000 walruses hauled out at the two rookeries on 6 and 8 July 1984. Judging by the traces left at the Rudder rookery in 1985, the latter was occupied by the maximum number during this time. In 1986, the walrus numbers in the Anadyr Gulf decreased, but, as in previous years, the highest number of walruses to haul out at both rookeries (18,000) was noted at the beginning of July. By the end of July, some of the walruses had migrated north, and the number of walruses remaining in the gulf for the summer stabilized up to the middle of September. The maximum number of animals hauling out during this period varied during the different years from 3000 to 6000 at the Meyechkin rookery and from 15,000 to 20,000 at the Rudder rookery. The second wave of migration of walruses from the Anadyr Gulf begins from mid September. By the end of October, 5000—6000 walruses haul out at both rookeries. The Russkaya Koshka rookery has been functioning since 1984. The maximum abundance of walruses at the rookery (4100 head) was noted in July 1986. Approximately 2000—3000 walruses can be found in the Russkaya Koshka area in August—September.

Age and sexual structure. In May, during the ice period, mixed rookeries were encountered in the central and southeastern part of the Anadyr Gulf, at which time the females bore their pups.

In the Cape Navarin area, the ice rookeries consisted exclusively of males. This type of sexual differentiation of the walruses in the rookeries and habitats was also observed in June. In the area extending from Cape Navarin to the Anadyr estuary traverse, the ice rookeries consisted of males, among which females were occasionally encountered. The congregation of walruses noted in the northern part of the gulf on 13 June 1982 consisted mainly of females and their young.

The age and sexual structure of the walrus take (Fig., a) does not reflect the real ratio in the Anadyr grouping of walruses due to the selectivity exercised by hunters from vessels, who prefer adult males; however, it does show that 11—21-year-old males predominate among the sexually mature animals (85.6%), and 11—13-year-olds predominate among the females (57.9%).



Age and sexual composition of walruses:
a - caught in the Anadyr Gulf in 1982 (p-207) from the "Zagorsky" vessel;
b - at Enmelen village in 1985 (p-78);
c - in Kresta Gulf in 1985 (p-91)

During the very first year of observations (1983), we established that the composition of the walruses at the Rudder rookery was mixed. The percentage of females was roughly 25—30% of the total number of walruses that hauled out, and 70% of the animals were not more than 15 years of age. Females with underyearlings were encountered throughout the season. Of the 105 animals caught at Enmelen and Nunlingran in July—August, 39.1% (41) were males and 61% (64) females. After the walruses hauled out at the Rudder rookery in 1984, the age and sexual composition remained stable throughout July—August.

Table 1. Age and sexual composition of walruses at the Rudder hauling-out grounds in 1984

Month, 10-day period		Age							Total
		oo adv	oo adv	up to 1 year	1 year old	2 years old	3 years old	4-7 years old	
					In 1984				
July	I	18/14.7	65/53.3	3/2.5	6/4.9	4/3.3	3/2.5	23/18.8	122/100.0
	II	24/13.0	85/46.0	13/7.0	6/3.2	4/2.2	5/2.7	48/25.0	185/100.0
	III	36/19.5	69/37.3	16/8.6	12/6.5	3/1.6	7/3.8	42/22.7	185/100.0
Aug.	I	49/16.5	144/48.5	23/7.7	20/6.7	11/3.7	5/1.7	45/15.2	297/100.0
	II	48/16.7	152/52.8	18/6.2	25/8.7	6/2.1	3/1.0	36/12.5	288/100.0
					In 1985				
July	I	79/24.8	160/50.3	18/5.7	14/4.4	17/5.3	4/1.3	26/8.2	318/100.0
	II	132/31.1	177/41.6	18/4.2	17/4.0	16/3.8	15/3.5	50/11.8	425/100.0
	III	245/44.8	178/32.5	17/3.1	14/2.6	15/2.7	15/2.7	63/11.5	547/99.9
Aug.	I	89/45.0	66/33.3	11/5.6	7/3.5	7/3.5	6/3.0	12/6.1	198/100.0

N o t e : Numerator - number of walruses, denominator - % of walruses

Sexually mature animals of both sexes predominated (64.1%). During this period, the males constituted 24.4%, and the females 74.6% (table).

The male/female ratio in the take of the hunters of Enmelen village in July and August did not differ significantly, amounting to 12.3% (10) and 87.7% (50) respectively in July, and 17.6% (9) and 82.4% (42) in August. An entirely different picture was observed by us in 1985. The number of sexually mature animals increased noticeably (75.7%), and the male/female ratio was 1:1.1. While there were 10—15% more females during the first 20 days of July, the males began to predominate noticeably during the last ten days of July (see table). The age pyramid (Fig., c) gives grounds for saying that groups from 10 to 15 years of age predominated among the sexually mature females (89.9%).

The carcasses of 81 walruses were examined at the Meyechkin rookery in 1985. Of these, 17.3% (14) were male, 32.1% (26) female, 29.6% (24) underyearlings, and 8.6% (7) 2—7-year-olds. The sex of 10 (12.4%) adult animals could not be determined. Visual determination of the age and sexual structure of the walrus rookeries showed that 81.3% (170) of them were made up of sexually mature animals, 41.1% (86) of them males, and 40.2% (84) females. Underyearlings constituted 13.4% (28), and 2—7-years-olds 5.3% (11). Of the 91 walruses caught in the Kresta Gulf, 31.9% were males and 68.1% females. 86.7% of the adult females were 9—15 years of age (Fig., b)

The 1987 season should be examined separately. Due to severe ice conditions, the walruses at the rookeries of the Anadyr Gulf hauled out only in mid July. A large part of the walruses from the Anadyr grouping apparently migrated to the Chukchi Sea. The maximum peaks of abundance at the Meyechkin rookery (6000) were noted at the end of July, and at the Rudder rookery (10,000) in mid August. The age and sexual composition of the walruses at both rookeries varied as follows: sexually mature individuals 66—86%, sexually immature animals 14—34%, young of the year 6—7%, and yearlings 3—5%. The male/female ratio approximated 1:1.

From the above data, we can conclude that the Anadyr grouping of walruses formed over the past 15—17 years. Its numbers reached 60,000 in 1985. Our analysis of the age and sexual structure gives grounds for

saying that this group of walruses will diminish in the nearest future. The percentage of the younger generation in it is much lower than the number of sexually mature animals. The decrease in the percentage of the young is due to the increased mortality of the pups during the first two years of life, caused, among other things, by an increase in the pressure of predators (polar bear, killer whale), a higher than usual mortality of underyearlings and year-old walruses in overcrowded coastal rookeries, and mostly by the anthropogenic factor. Off-shore walrus hunting in the Anadyr Gulf is based 60—80% on female walruses, which results in a higher than usual mortality of the younger age groups.

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Observations on the abundance and distribution of walruses in the Karaginski Gulf in 1987

by Ye.V. Kitayev (Kamchatrybvod)

In the 19th century, prior to the mass obliteration of walruses, the southern boundary of their distribution off the shores of the Kamchatka Peninsula passed through the Karaginski Gulf (Kosygin, Sobolevsky, 1971). By the 1960s, when the walrus population was in a state of depression, this boundary shifted northward, towards Cape Navarin (Kosygin,

Sobolevsky, 1971). By the 1980s, the hauling-out grounds on Verkhoturov Is. and Karaginski Is., which had become extinct during the years of intensive walrus hunting, had begun to function again. In 1987, we conducted a study on the abundance, seasonal distribution, spatial structure and mortality of the walruses in the Karaginski Gulf, the location of the southern peripheral part of the range of this species.

Data was gathered from June to December. Small groups of animals (up to 50) were counted one by one, while the the numbers of the larger congregations in the water was determined by visual estimation. The abundance at the hauling-out grounds was determined by setting up sample plots and then extrapolating the results, and also by determining the area of the rookeries, knowing that one animal occupied approximately 3 sq. metres. Two persons carried out the calculations at the same time, and if there was some discrepancy in the latter, the results were averaged out. Permanent observations at the hauling-out grounds (33 days on Verkhoturov Is., 2 days on the Lekalo sand bar) were carried out with twice-daily estimates (at 9 am and at 7 pm). Surveys from vessels along the route Ossora Bay—Lozhnykh Vestei Bay—Cape Golenishchev—Verkhoturov Is. were carried out on August 4—5th and September 3rd—5th, and enroute from Lozhnykh Vestei Bay to Ossora Bay again on September 26—28th and October 23rd—24th. Traverse route surveys from a motor boat covered 176 km of the coastline of the Karaginski Gulf, Karaginski Is. and Verkhoturov Is., and the segment from Cape Golenishchev to Cape Krasheninnikov (Karaginski Is.) was surveyed twice, in June and in September. Aerial surveys (AN-2, altitude 100—200 m) in September—December, with a flight time of 32 hours, covered the coastal zone from the mouth of the Ozernaya R. in the south to the mouth of the Tilichkin R. in the north, including Karaginski and Verkhoturov islands, a total distance of about 450 miles. Eight correspondents submitted their survey data on walrus encounters, the abundance of walruses, and the number of carcasses found in different parts of the region.

The appearance of walruses in the coastal zone, which means in the field of view of the observers, is due to the thawing of the ice. The breakup of the ice substrate in May—June marks the onset of the pelagic

period in the life of the walruses, which precedes the formation of permanent coastal rookeries. The change in stations in the Karaginski grouping of walruses is followed by migration northward from the Ozernay R. area of the peninsula, which lasts 2—3 weeks. Groups of walruses migrating north were noted off the western coast of Karaginski Is. on June 15th and 16th.

The hauling-out grounds on Verkhoturov Is. began to function at the end of June. The entire Karaginski walrus stock gathered here in July—September. The southern boundary of the foraging area in the Litke Strait extended along the Karaga Bay—Lozhnykh Vestei Bay line. The Verkhoturov walruses used Cape Golenishchev on Karaginski Is. as an additional rookery. Up to 300 walruses were counted there at the beginning of July (V.N. Burkanova). On August 14th and September 21st, we noted 10 walruses on a kekur* off this cape everyday of the surveys. On October 7th, the walruses formed a rookery on the Lekalo sand bar from the side of Lozhnykh Vestei Bay, while the foraging area shifted south of the line joining Karaga Bay and Lozhnykh Vestei Bay. The departure of walruses from this rookery to the foraging area has been traced by us up to Cape Severo-Zapadnyi (literally Northwestern). The rookery on the Lekalo sand bar functioned up to the middle of December, up to the formation of coastal slush ice.

The walruses' stay at the Verkhoturov rookery is characterized by a clearly defined irregular periodicity. Its dynamics are affected by meteorological conditions, foraging conditions in the area adjacent to the rookery, and by the degree of satiation of the animals hauling out there. During a strong wind (wind force 3), walruses do not haul out at this rookery. The hauling-out period during August ranged from 103 to 47 hours, averaging 79 hours). The abundance of animals during the haul-out period varied considerably. In August, it varied from 1800 to 4750 individuals, the average abundance at the rookery amounting to 2700 walruses. The maximum abundance, 5000 walruses, was noted on August 30th.

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* bank of gravel pushed ashore by river ice; in Siberia, conical rocks on a sea coast - transl.

The surveys conducted on November 10—11th on the Lekalo sand bar showed that approximately 2000 walruses hauled out there.

Three types of walrus groupings are encountered, namely coastal rookeries, congregations of foraging walruses in the water, and small groups of 4—15 walruses in the water, usually close to a rookery.

In the Karaginski Gulf, three rookeries are known to function during the open-water period; these are the rookeries on Verkhoturov Is., the Lekalo sand bar and Cape Golenishchev. Mass and prolonged hauling-out of walruses takes place at the first two. A small number of walruses haul out for a short time on Cape Golenishchev.

A congregation of 50—1000 foraging walruses were encountered in different areas of the gulf, in Lozhnykh Vestei Bay on August 5th, on the Markelovskaya estuary traverse on August 11th, and on the Ploksan estuary traverse on September 27th.

Small groups consisting of up to 15 walruses were seen in the water in the vicinity of the rookery, while most of the herd were on their way to forage in the sea.

Boat, traverse route and aerovisual surveys provided data on walruses that had died. Communications from off-shore fishermen added to this information. Fifty-two carcasses were reported in all. Thirteen of these were examined. They showed no signs of gunshot wounds or other anthropogenic signs of death. Two of the animals had lost both tusks while they were still alive. One walrus had died at the Lekalo rookery. Severe bruises in the region of the mouth and anus, and prolapse of the prepuce indicated that the adult male walrus was most likely crushed by other walruses during the mass departure from the rookery. The causes of death in the other cases are unknown, since the animals were cast out onto the shore after a long period in the sea. Measurements of body length showed that all of the animals were adults with a body length of 330 cm and more. Of the ten carcasses determined for their sex (found stretched out on their backs), three were females.

Consequently, walruses inhabit the Karaginski Gulf throughout the ice-free period. Three permanent coastal rookeries with different functioning periods currently exist in the Karaginski Gulf; they are the Verkhoturov, Golenishchev and Lekalo rookeries. In July—September, the

walruses occupied the northern part of the gulf, hauling out on Verkhoturov Is., while their foraging grounds in the south were bounded by the line connecting Karaga Bay and Lozhnykh Vestei Bay. In October, the Karaginski herd familiarized itself with the southern part of the gulf, forming a rookery on the Lekalo sand bar. The foraging area shifted south of the line connecting Karaga Bay and Lozhnykh Vestei Bay. It was the first time in a hundred years that walruses rested on the Lekalo sand bar for such a long period in autumn. Coastal rookeries are formed exclusively by adult males.

The social structure of the Karaginski herd of walruses is characterized by three spatial formations, namely a coastal rookery, a congregation of 50 to several hundreds of walruses feeding in the water, and small groups of 4—15 walruses in the water.

The mortality of walruses is not due to anthropogenic factors. Female walruses are encountered among the carcasses cast out onto the shore of the gulf.

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Data on the biology of the Pacific walrus

(expedition of the "Zakharovo" hunting and fishing vessel in 1985

by A.A. Kibalchich (VNIRO)

In the spring of 1985, we managed to conduct a routine Soviet—American expedition to study the biology of seals and the walrus in the North Pacific and adjacent seas of the Arctic Ocean. Four specialists from each country participated in the "Zakharovo" expedition. Extensive biological material was collected on the pinnipeds of the Bering and Chukchi seas, and the results of a catch of about 1000 walruses were analyzed. The walruses were caught in areas 1, 2 and 5 (Fig. 1). Some of the work was carried out in the American economic zone. Under the research program, the American side issued permission to harvest 200 Pacific walruses, 200 ribbon seals, 100 ringed seals, 200 harbour seals, 300 bearded seals and 100 northern sea-lions. In view of the low numbers of true seals and sea-lions during the period of our investigations (March 19th—31st), mainly walruses were caught in this area. As in previous years (1976 and 1981), the eastern, so-called Bristol, grouping of walruses consisted of sexually mature females and their pups, as well as a small number of physically mature males. The male/female ratio of the animals caught was 18:127. Sixteen of the 18 males were over 13 years of age. Thirteen of the mature animals were found to be at the stage of active spermatogenesis. The composition and physiological condition of the sexually mature females are shown in table 1. By March 26th, only one female 17 years of age had a fully mature unperforated follicle, i.e. had not ovulated. The period of heat was probably coming to an end at this time. The absence of sperm in some of the sexually mature males was further evidence of this.

The different relative number of pregnant and ovulated females in a sample (36.2% and 26% respectively shows that the hunt was carried out largely in groupings of females that were preparing to give birth. Congregations of this type were noted in the Kuskokvim Gulf at the beginning of March 1981, when females with the same and only one

physiological condition of the reproductive organs (barren, pregnant, ovulated, or estral) were caught at individual rookeries.

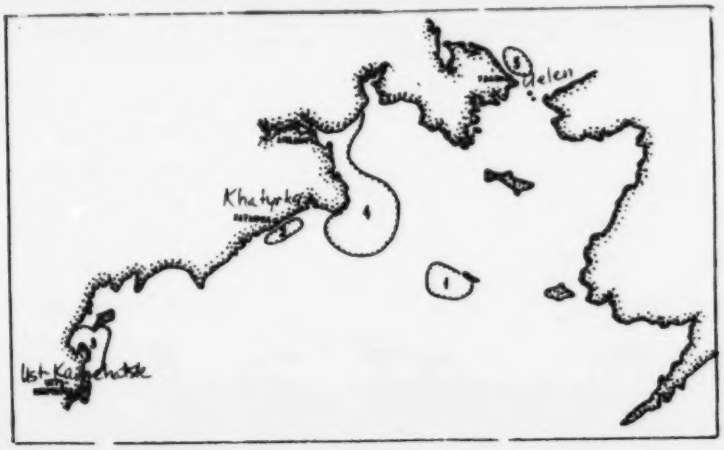

Fig. 1. Map of areas covered by the "Zakharovo" expedition in the Bering and Chukchi seas in 1985: 1—5 - boundaries of areas

The data of 1976, 1981 and 1985, which were gathered practically in the same area, showed that by the end of March, the absolute majority of the females in heat (83%) ovulated, whereas no females with ripe follicles were present among the 38 adult females caught from 20 March to 18 April 1976. Most likely, all of the animals ready for impregnation and conception had already been in heat. Only five of the females from the spring sample of 1981 had follicles 7, 11, 11, 7 and 11 mm in diameter respectively at the age of 5 to 7 years. Apparently, young female walruses ovulate later than those that have already given birth. A similar picture, i.e. later spermatogenesis, was noted in young male walruses. In his study of northern fur seals, V.A. Vladimirov (1982) noted that approximately 30% of the 3—4-year-old females haul out and mate only in August and even during the first and second ten days of September, though it had been generally accepted that the period of heat in fur seals ended at the end of July. The shifting of sexual activity in young animals to a later date is apparently an adaptation which enables polygamous species to utilize their reproductive potential to a fuller extent. In this way, young males

avoid strong competition from more mature and stronger males at the initial stages.

The embryos from all the pregnant females in the sample were measured and weighed (table 2). An 18-year-old female had two male embryos weighing 49 kg each in the right cornu. The 30 x 47 mm yellow body of fetation did not differ in any way externally from those of other pregnant females. This was probably a case of monozygotic twins. Two fetuses have been noted in walruses by other researchers as well, but this was the first case of monozygotic twins.

After taking the limit of samples of the Pacific walrus in the economic zone of the USA, the vessel moved into the western part of the Bering Sea, and from April 9th to 20th worked in area No. 2 (see Fig. 1).

During the winter—spring period, purely male rookeries are found in the waters adjacent to the Koryak coast of the Kamchatka Peninsula and farther north up to Cape Navarin. These are the so-called Koryak—Khatyrka grouping of walruses. These rookeries of up to 20-30 walruses consisted mainly of physically mature adult males (table 3). The average age of the animals caught was 20.4 years, and the day on which they were caught made no signifcant difference, i.e the variations did not exceed ±6 years. Spermatogenesis was noted in only 10 of the 261 males. For six years now, the vessels of Sakhalinrybprom have been hunting the Koryak—Khatyrka grouping of walruses for experimental purposes. The hunting limit during this period has increased from 1000 to 1400 walruses; therefore, the number of animals caught has also increased. In 1985, the full limit of walruses was taken.

A comparison of the spermatogenic activity of the animals from the Koryak—Khatyrka (western) and the Kuskokvim (eastern) groupings shows that it is significantly higher in the latter (Kibalchich, 1982, 1986). As we have already mentioned, the animals forming the western congregation may include some of the males that do not take part in the breeding process (Kibalchich, 1982). Exploiting this part of the population, we must organize and conduct regular aerial surveys of the western grouping of walruses in the early spring in order to determine the effect of hunting on its numbers.

Table 1. Reproductive condition of the female walruses from area No. 1

Age	No.	Pregnant	Lactating	Barren	Ovulated	Miscarried	Juvenile
7	2	1	-	-	-	-	1
9	1						1
10	1	1					
11	2	1		1			
12	2	1	1				
13	5	4	1				
14	6	3	2				
15	8	4		2	2		
16	9	1	1	1	6		
17	8	3	2	2	1		
18	14	4	6		4	2	
19	7	5	2				
20	10	3	2	3	2		
21	6	2	2		2		
22	8	2	1	1	3	1	
23	8	6	1		1		
24	6		1	4	2	1	
25	7	2	4	2			
26	1				1		
28	1			1			
30	1				1		
33	1				1		
35	1	1					
36	1	1					
Over 20*	10		2	4	5		
Total:	127	46 (36.2%)	28 (22.0%)	21 (16.5%)	33 (26.0%)	4 (3%)	2

Note: M_{age} = 19.00±0.43; *Females over 20 years of age, whose exact age could not be determined.

Table 2. Size and mass of Pacific walrus embryos (March)

Males			Females		
Age of female	Mass, kg	Length along outer body curve, cm	Age of female	Mass, kg	Length along outer body curve, cm
36	40	128	-	46	127
25	58	146	25	43	133
17	43	131	23	25	120
22	48	143	23	42	127
			23	53	142
22	42	138	21	45	140
20	45	138	20	46	127
19	48	135	21	43	132
19	52	141	20	34	118
19	53	134	19	40	127
19	49	137	18	37	133
18	40 (twins)	-			
	40	-	18	49	144
18	46	136	17	42	137
17	56	149	17	55	145
15	56	-	16	42	133
14	54	139	15	-	137
13	54	143	15	45	137
13	49	142	14	47	139
14	40	136	15	52	136
23	48	140	13	40	136
23	43	135	13	39	126
			12	46	139
			10	45	131
			9	42	137
			7	48	136
			11	44	132

Note: Mo = 48±0.7; n = 21; b = 5.89; b_{n-1} = 6.03.
Mo = 43.6±0.7; n = 26; b = 6.04; b_{n-1} = 6.16.

Table 3. Composition of males caught from the Koryak—Khatyrka grouping

Age	No. of individuals			Average mass, kg
	of a definite age	%	weighed	
7	1	0.4	1	870
8	3	1.2	3	710±52
9	1	0.4	1	825
10	5	2.0	5	662±38
11	5	2.0	4	1005±109
12	2	0.8	2	895±78
13	1	0.4	1	820
14	9	3.6	8	1109±51
15	13	5.2	11	1080±69
16	11	4.4	10	1111±34
17	16	6.4	15	1170±32
18	16	6.4	12	1170±63
19	14	5.6	14	1242±40
20	29	11.6	28	1184±26
21	29	11.6	28	1240±27
22	7	2.8	6	1303±83
23	20	8.0	17	1236±29
24	17	6.8	16	1241±42
25	14	5.6	13	1301±40
26	19	7.6	16	1279±34
27	6	2.4	6	1215±70
28	5	2.0	5	1131±88
29	1	0.4	1	1320
30	1	0.4	1	1210
31	3	1.2	3	1213±35
33	1	0.4	1	1240
Total:	249		227	

N o t e : Average age - 20.4 years, mass - 1240 kg.

Table 4. Age of walruses caught in the Chukchi Sea

Age	Males		Females	
	No.	%	No.	%
1	2	0.5	-	-
2	1	0.25	2	1.04
3	1	0.25	-	-
4	-		1	0.52
5	3	0.75	1	0.52
6	2	0.5	-	
7	3	0.75	4	2.09
8	11	2.78	2	1.04
9	7	1.77	2	1.04
10	8	2.02	3	0.75
11	12	3.03	4	2.09
12	14	3.54	13	6.8
13	17	4.30	14	7.32
14	24	6.07	20	10.74
15	28	7.08	12	6.28
16	32	8.1	15	7.85
17	35	8.86	18	9.42
18	31	7.84	12	6.28
19	26	6.58	16	8.37
20	20	5.06	12	6.28
21	32	8.1	11	5.75
22	12	3.03	8	4.18
23	23	5.82	7	3.66
24	17	4.30	3	1.57
25	9	2.27	6	3.14
26	10	2.53	2	1.04
27	7	1.77	1	0.52
28	2	0.5	-	
29	4	1.0	-	
30	1	0.25	1	0.52
32	1	0.25	-	
33	-		1	0.52

Note: Average age of males >8 years=17.83, n = 383.
Average age of females >8 years=17.18, n = 181

From June 29th to July 12th, walrus hunting was carried out in the Chukchi Sea (area No. 5, Fig. 1) at large ice rookeries consisting of up to tens of thousands of animals. These rookeries were formed mainly by females and their pups. Male rookeries formed basically by young animals prevailed in the southeastern part of the area.

Analysis of 159 reproductive tracts of sexually mature females showed that 41.5% of them had given birth that particular year, or had miscarried at the later stages of pregnancy. Embryos measuring from 5 to 120 mm were found in 13.8% of the females. 24.5% of the females showed fully formed yellow bodies, though embryos were not found in them. Apparently, the implantation of the blastocyst had not yet begun. This may be an indication of the lengthiness of the period of heat and the variability of the latent stage of pregnancy in walruses. The relative number of females that had given birth and the number that had become pregnant in the sample are similar (41.5% and 38.4% respectively), and lie within a 7.8% range of error. Examination of the mammary glands and the cornua of the uterus showed that only 49 of the 66 females that gave birth were lactating in the first half of July. This means that approximately 24% of the yearlings died. This figure apparently includes the stillborn and the pups aborted at the later stages of gestation, since the mortality during the first year of life was determined by the difference between the number of females that had given birth and those with pups, established on the basis of lactation and placental scars.

The age composition of the walruses caught (table 4) shows that adult animals formed the basis of the walrus harvest. This is the result of the selective hunting of larger animals.

A comparison of the data and hunting results since 1976, when the first data on the reproductivity of walruses in early spring were obtained, have not revealed any significant changes in the level of the birth rate and pregnancy rate. There has been a slight decrease in the density and abundance of male rookeries on the Koryak coast, which calls for a more detailed study of this group of walruses.

Table 4. Age of walruses caught in the Chukchi Sea

Age	Males		Females	
	No.	%	No.	%
1	2	0.5	-	-
2	1	0.25	2	1.04
3	1	0.25	-	-
4	-		1	0.52
5	3	0.75	1	0.52
6	2	0.5	-	
7	3	0.75	4	2.09
8	11	2.78	2	1.04
9	7	1.77	2	1.04
10	8	2.02	3	0.75
11	12	3.03	4	2.09
12	14	3.54	13	6.8
13	17	4.30	14	7.32
14	24	6.07	20	10.74
15	28	7.08	12	6.28
16	32	8.1	15	7.85
17	35	8.86	18	9.42
18	31	7.84	12	6.28
19	26	6.58	16	8.37
20	20	5.06	12	6.28
21	32	8.1	11	5.75
22	12	3.03	8	4.18
23	23	5.82	7	3.66
24	17	4.30	3	1.57
25	9	2.27	6	3.14
26	10	2.53	2	1.04
27	7	1.77	1	0.52
28	2	0.5	-	
29	4	1.0	-	
30	1	0.25	1	0.52
32	1	0.25	-	
33	-		1	0.52

Note: Males - average age >8 years = 17.83, n = 383;
Females - average age >8 years = 17.18, n = 181

Table 5. Reproduction rate of walruses, determined by the annual percentage of pregnant females among the sexually mature ones

% of pregnant females	Source of material	Author, year
50	Kara Sea	K.K. Chapsky, 1936
39	Bering Sea	D. Buckley, 1958
39	Eastern part of Bering Sea	D. Scott, 1959
35	Canadian Arctic	A. Mansfield, 1958, 1959, 1960
39	Eastern part of Bering Sea	F. Fay, 1955
25.9	Western part of Bering and Chukchi seas	V.I. Krylov, 1966
40	Eastern part of Bering Sea	J. Burns, 1965
46	Based on the material of V.I. Krylov and J Burns	G.A. Fedoseyev and V.N. Goltsev, 1975
38	Eastern part of Bering Sea	F. Fay, 1982
26	Area of Wrangel Is.	A. Kibalchich, 1972-1974
40	Eastern part of Bering Sea	A. Kibalchich, 1976
34	Western part of Bering and Chukchi seas	A. Kibalchich, 1978
41	Eastern part of Bering Sea	A. Kibalchich, 1981
26.6	Western part of Chukchi Sea	A. Kibalchich, 1983
32	Northwestern part of Bering Sea	A. Kibalchich, 1984
36.2	Eastern part of Bering Sea	A. Kibalchich, 1985
38.4	Western part of Chukchi Sea	A. Kibalchich, 1985

Pacific walrus surveys. Some of the data obtained during the survey on the distribution of walruses, and correlation of the results of previous investigations and the literature have enabled us to approach the question of Pacific walrus surveys more critically.

The rational use of the natural animal resources call for knowledge of the principal biological parameters of the exploited populations, species and communities. These parameters include abundance, sex ratio, age of sexual maturity and breeding in males and females, reproductive capacity, life span, gestation period, organization of reproduction (monogamy, polygamy, promiscuity, etc.), natural mortality and mortality due to walrus hunting, etc.

Table 6. Dynamics of Pacific walrus abundance (based on the data of aerial surveys)

Year	Range of abundance (thou. head)	Average abundance (thou. head)	Author, year
1958	-	40	G.A. Fedoseyev, 1960
1960	78-113	95	K. Kenyon, 1960
1960	70-100	85	K. Kenyon, 1960
1960	-	50	G.A. Fedoseyev, 1962
1964	47-71	59	V.N. Goltsev, 1968
1970	-	101	V.N. Goltsev, 1972
1975	140-200	170	J. Estes, V.N. Goltsev, 1984
1980	270-290	280	G.A. Fedoseyev and Ye.V. Razlivalov, 1981 A. Johnson, J. Burns, V. Dussenberry and R. Johns, 1981

Knowledge of the abundance of a population, natural and hunting mortality, and reproduction makes it possible to organize rational utilization of walruses, which leads to maximum stable harvests over an unlimited period under the conditions of relative stability of the ecosystem.

The Pacific walrus has long been the target of hunters along the shores of the Chukchi Peninsula and Alaska. The ancient camp sites and still existent coastal settlements are located next to the coastal rookeries and migration routes of walruses. With the demise of whale hunting in the North Pacific, the whalers took up walrus hunting from the vessels at the end of the 19th century, which greatly undermined the numbers of these animals.

One can say that with the coming of Europeans to the areas inhabited by the Pacific walrus, the status of its population began to depend mainly on the methods and intensity of walrus hunting.

At the end of the 19th century, the walrus numbers in the North Pacific were estimated at 200,000 (Fay, 1957). This figure, which was derived empirically, was probably just a very rough estimate, since the commercial "stock" of males alone, derived by "cohort analysis", amounted to 155,000 in 1931 (Kibalchich, Borodin, 1982), while the abundance determined by aerial photographic survey in 1980 was 270,000-290,000.

Even a quick glance at the status of the Pacific walrus population, based on the data of various authors (table 5), shows that the rate of growth of abundance does not correspond to the rate of reproduction (table 6). If we eliminate the highest and lowest values from the table, we get an average 37% of the sexually mature females giving birth annually. Surveys of female producers at ice rookeries have shown that they constitute about one-half of the animals in mixed and breeding congregations, and their number for the 1980 population amounted to 110,000 or 39% of the total numbers. V.I. Krylov gives a figure of 35% for 1967. With this birth rate, the sexually mature females will give birth to 14.5% of the total numbers annually. This does not quite account for such a high increase in the numbers of the subspecies. In all probability, there has been an improvement in the methods of estimation; hence, this visible intensive growth of the population.

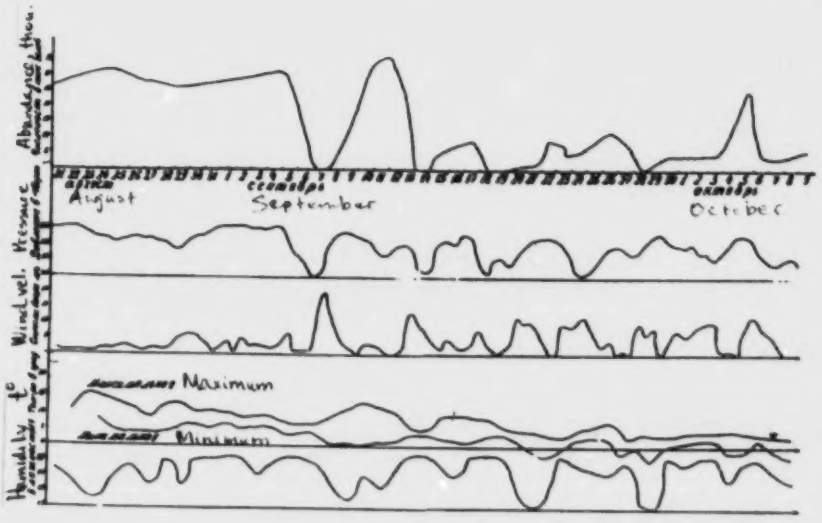

Fig. 2. Dependence of walrus numbers at the Arakamchechen rookery on atmospheric pressure, wind velocity, temperature and air humidity

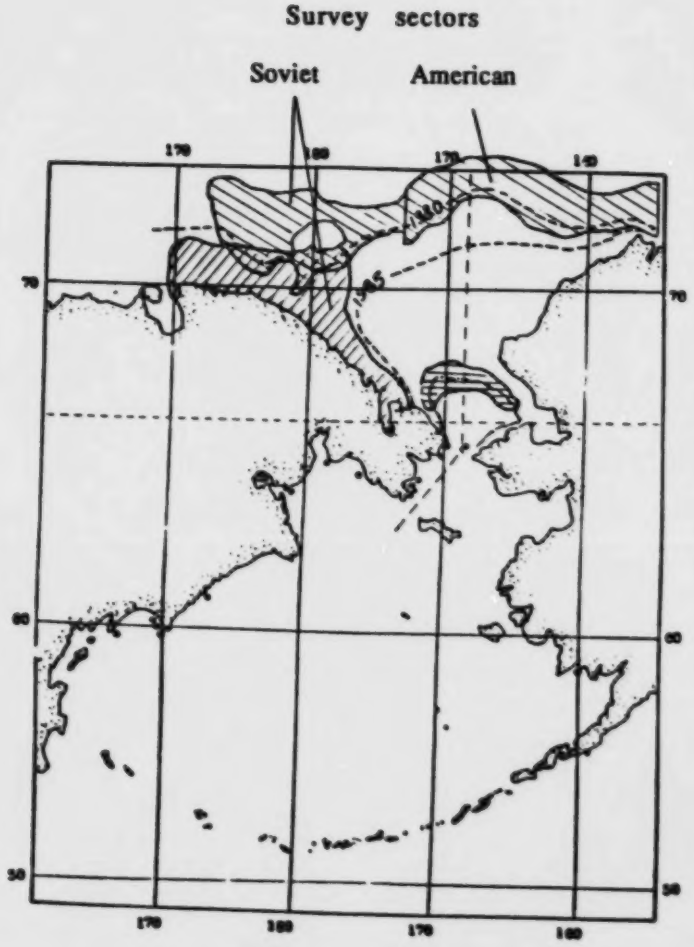

Fig. 3. Distribution of the Pacific walrus in summer and autumn: - - - 1980 - ice edge in September; - - - - in July; - distribution of the walrus in July; - survey area in 1980 (Soviet and American zones); - in 1985 (Soviet zone only); - coastal rookeries

The first attempts to count and study sea mammals from an aircraft were undertaken by S.V. Dorofeyev in 1930 in the Sea of Okhotsk (Dorofeyev, 1940). P.G. Nikulin first conducted an aerovisual survey of the Pacific walrus in 1958 (Krylov, 1986). In September—October 1960, G.A. Fedoseyev (1982) estimated the numbers of the Pacific walrus population at 50,000 by aerial photographic survey at hauling-out grounds and by counting the animals on ice floes. Aerial surveys were also conducted in

1970, 1975, 1980 and 1985, the latter two simultaneously with American scientists, each side in their own economic zone. As a rule, all the aerial surveys were conducted in September—October. On the one hand, the lowest ice cover in the Chukchi and East Siberian seas and the highest occupancy of the coastal hauling-out grounds recorded during this period made it easier to conduct the surveys. On the other hand, the ice edge at which rookeries are usually concentrated was the most extensive, which meant longer flights over greater distances. For example, the survey routes over USSR waters totalled 37,000 km in 1980, and 22,000 km in 1985 (Fedoseyev, 1981; Fedoseyev, Razlivalov, 1986). The American scientists covered a distance of 4863 km in the eastern part of the Chukchi Sea in 1980. Furthermore, September and October in the Eastern Arctic are characterized by frequent abrupt pressure drops and gale winds, which also prolongs the surveys due to unsuccessful flights over abandoned hauling-out grounds and ice floes.

Our investigations at the Blossom and Arakamchechen rookeries showed that the behavior of the walruses depended to a large extent on the changes in pressure and wind velocity (Kibalchich, 1978, 1982). When the pressure drops, the walruses usually leave the rookery (correlation coefficient 0.64 when the effect of wind velocity is ruled out). The same is observed with an increase in wind velocity (correlation coefficient 0.35). Obviously, the reaction to a pressure drop develops in connection with the unfavorable factors that follow this phenomenon (an increase in wind velocity and the splash zone, a drop in temperature, precipitation, etc.) (Fig. 2). Perhaps the walruses are forced to return to the sea also because the increasing noise of the surf makes it more difficult for the walruses to communicate with each other vocally. Our investigations have shown that the Arakamchechen rookery has the highest occupancy rate up to September 10th in calm weather or when the wind velocity does not exceed 3—5 m/s and the atmospheric pressure is not less than 1008 mbar. We can say that this holds true for all the rookeries of the Bering Sea.

The migration of the Pacific walrus is characterized by the fact that, in summer, females with pups up to 7 years of age and a few (about 10%) of the adult males migrate to the Chukchi Sea and spread out along the ice edge, while the sexually mature males remain in the Bering Sea and haul

out at coastal rookeries (Kibalchich, 1982); this enables us to count these different groups separately.

Analysis of the summer ice conditions over a number of years tells us that the best time to conduct walrus surveys is usually at the end of June—July, when nearly all the ice in the Bering Sea breaks up and the males remaining in the area haul out on shore. A small ice-free area in the shape of a U directed at Wrangel and Herald islands forms in the Chukchi Sea as a result of the effect of a branch of the Herald Current (Fig. 3). Here, females migrating in the Chukchi Sea in summer with their pups and a small number of young males gather at the ice edge. Congregations of this type were observed by us on 17-21 July 1978 and from 29 June to 12 July 1985, and, according to V.N. Sadovov, at the beginning of July 1984. F. Fay (1982) and other observers have also witnessed the formation of such congregations.

The concentration of pinnipeds on ice floes and in the water at this or that time of the year usually depends on their physiology. Animals congregate mostly during the periods of breeding, moulting and migration. Our case is characterized by an overlap of congregation stimuli, i.e. the peak of moulting (Nikulin, 1940 and Fay 1982) and the time of migration (Fay 1982; Kibalchich, 1982).

Comparing the prerequisites of the aerial Pacific walrus surveys in July and September, we can definitely give preference to the earlier ones. The area of walrus distribution on the ice at the beginning of July is more than 10 times smaller than in September. The occupancy of the coastal hauling-out grounds is the highest, and the weather conditions are conducive to aerial photographic survey. On the basis of this, we can say that by conducting surveys in July, we can cut costs considerably and determine the numbers of the Pacific walrus population more accurately.

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Observations on the distribution and abundance of northern sea-lions on the Commander Isls. during 1978—1987

by V.V. Vertyankin and V.S. Nikulin (Kamchatrybvod)

Over a long period of time, the workers of the Commander Isls. Inspectorate of Kamchatrybvod have been conducting regular observations on sea-lions. As a result of the investigations, significant changes have been noted in the distribution and abundance of the animals at the hauling-out grounds of the Commander Isls.

At the present time, the sea-lions form five rookeries, three of which are located on Bering Is. (Cape Manati, Cape Severo-Zapadnyi, Cape

Yushin), one on Ariy Kamen Is., and one on Mednyi Is. (Cape Yugo-Vostochnyi). Of the existing sea-lion rookeries, four are shared with fur seals. Since 1978, the rookery in Gladkovskaya Bay (Bering Is.), where 152 sea-lions were counted in 1977, has practically ceased to exist. By 1982, sea-lions had almost completely stopped hauling out at the rookery in Krasnaya Bay on Mednyi Is. (only 9 mature male fur seals were noted here in March 1988). Females did not appear here at all in 1988, though groupings resembling harem rookeries, but not the birth of pups, had been noted here earlier. No sea-lions have been encountered in Gladkovskaya and Krasnaya bays over the past 5-6 years; therefore, these rookeries can apparently be regarded as temporarily extinct.

One to three sea-lions are noted annually at the Urilyem fur seal rookery on Mednyi Is.; these animals do not form large rookeries here, though fish conservation inspector V. Nechiporenko has reported seeing 30 sea-lions at this rookery on 15 July 1970. Occasional haul-outs of sea-lions are also noted beyond the rookeries on Bering Is. (Cape Vykhodnoy Rif, Vodopadskaya and Snastnaya bays, in the vicinity of Steller's Arc, Cape Peresheyek Ostrovnoy, and in other places along the coast); as a rule, these are sick animals.

At the end of 1960, the numbers of the sea-lion on the Commander Isls. reached the highest level ever noted during the observation period, and this occurred in winter. For example, the number of animals at the rookeries in February and September 1968 was 10,850 and 1742 respectively. Due to unknown causes, the numbers of the sea-lion on the Commander Isls. began to diminish in the years that followed, and by 1977 dropped to 4578 (Mymrin, Fomin, 1978).

A year later, the numbers of the sea-lion dropped by more than 1400 overall for the archipelago. The decrease continued in 1979; after that, there was a sharp drop in the number of sea-lions, the low level stabilizing up to 1987. The exception was 1983, when the herd of sea-lions unexpectedly increased to 3300, and the overall increment was due to an increase in the number of sea-lions on Cape Manati (table 1).

Table 1. Dynamics of sea-lion abundance at the rookeries of the Commander Isls. during the spring—summer period from 1978 to 1987

Rookery	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Severo-Zapadnoye	68	?	?	21	28	13	31	8	132	35
Yushin	?	40	?	?	30	17	40	30	56	30
Manati	800	970	700	900	616	1900	1000	820	1500	1000
Gladkov-skaya	nil	nil	nil	11	nil	nil	nil	nil	nil	nil
Total for Bering Is.	868	1010	700	932	643	1930	1071	858	1688	1065
Yugovos-tochnoye	1283	600	1165	1200	950	720	800	800	890	1200
Krasnaya	750	690	204	200	9	nil	nil	nil	nil	nil
Total for Mednyi Is.	2033	1290	1369	1400	959	720	800	800	890	1200
Ariy Kamen Is.	254	600	70	60	730	680	200	270	50	150
Total for Commander Islands	3155	2900	2139	2392	2332	3300	2971	1928	2628	2415

The numbers of the sea-lion at the rookeries vary not only with the seasons, but also during each month of the year, as we can see in table 2 which contains the highest results of a single survey of sea-lion abundance for each month. Sometimes, there were no sea-lions at all at the rookery during the surveys. The most complete picture of abundance is observed at the rookeries adjacent to the village; the rest are visited occasionally because they are difficult to reach. Whereas the numbers of the sea-lion had previously peaked in winter, the tendency for the given period was maximum abundance in spring—summer, and the total numbers of the sea-lion at the rookeries currently stand at 2400—2600. These changes are most likely related to the qualitative composition of the rookeries as well.

Table 2. Seasonal changes in the numbers of the sea-lion at the rookeries of the Commander Isls. in 1987

Month	Rookery				
	Severo-Zapadnoye	Yushin	Manati	Yugo-Vostochnoye	Ariy Kamen
I	4	7			
II	4	3			
III	2	8			150
IV	1	14	550		120
V	7	27			
VI	14	30	1000	1200	10
VII	35	21	800	1000	
VIII	77	27		500	
IX	266	49	15		
X	300	25			
XI	201	22			
XII	150	8			

There are two sea-lion breeding grounds on the Commander Isls., the Yugo-Vostochnoye (literally Southeastern) and the Manati breeding grounds. At the first one, the first pups appeared in 1969 (Chelnokov, 1971), and by 1980 there were already 55 of them (Chelnokov, 1983). Later, according to the observations of KoTINRO worker F.G. Chelnokov, the growth in the numbers of newborn did not cease, peaking at 167 in 1987. At the Manati rookery, the first pups (2) were noted on 27 June 1983 by Kamchatrybvod inspector V.N. Burkanov. In 1984, the survey of sea-lion abundance at this rookery was carried out from a motor boat without landing on shore, which means that the newborn could have been overlooked. By 1985 (June 19th), the number of newborn went up to 4; three of the pups were female (the sex of the one that had died is unknown). On 11 June 1986, there were already 8 sea-lion pups (7 males and one female), and on 29 June 1987 there were 22 pups (8 males, 12 females and 2 unknown).

The formation of this breeding ground was at first adversely affected by polar fox which killed the newborn sea-lions (Vertyankin, 1986). When Cape Manati was visited in 1987, there were not very many polar fox in the vicinity of the breeding ground, and they did not cause any damage to the newborn sea-lions; in 1986, however, polar fox abounded (up to 10-12

pairs in the vicinity of the rookery), and 50% of the newborn sea-lions were found to have chewed off front and hind flippers (up to 1/3 of their length). The fate of the injured pups is unknown. Nevertheless, the growth rate of the Manati breeding ground is much higher than that of the Yugo-Vostochnaya breeding ground.

On 30 June 1988, for the first time since a sea-lion rookery began to exist at the Severo-Zapadnoye (literally Northwestern) breeding ground, the birth of a sea-lion was observed here (personal communication of KoTINRO worker D.I. Chugunkov), and soon afterwards the mating of adult sea-lions. In the middle of July 1987, a female and her pup were noted at this rookery; they had probably migrated here from another breeding ground (Manati being the closest one), for they had not been seen on the shore prior to this. Newborn sea-lions begin to swim at an early stage of their development; this is confirmed by the fact that 21 pups were observed at the Manati rookery at the end of June, and by July 7th only 8 pups were seen on the shore, and when people approached, they escaped into the water with the adult animals.

A characteristic feature is that the appearance of harem rookeries was preceded by the discovery of miscarried sea-lion fetuses on the territory of the hauling-out grounds. These were noted many times at the Yugo-Vostochnoye rookery (in spring) after the formation of stable harem rookeries. One miscarried fetus was found on 20 March 1978 and one on 26 May 1982 at the Manati rookery, a male fetus in the first case and a female in the second.

During a sea-lion survey on Ariy Kamen Is., miscarried fetuses were found almost every day, 5 on 9 March 1978, 2 on April 5th, one on April 25th, and two pregnant females with embryos a metre in length were caught here on May 8th. Three miscarried fetuses were noted and a pregnant female was caught at this rookery on 23 March 1979, and two miscarried fetuses (one male) were found and a pregnant female caught on the same day in 1987. Three fetuses were found at this hauling-out place on 10 April 1985. The preservation of the embryos on Ariy Kamen Is. can be attributed to the absence of land predators, polar fox, which are present at the rest of the sea-lion rookeries of the archipelago, and the

absence of miscarried fetuses during certain years may be due to the latter being washed out into the sea by gale waves.

With the appearance of pregnant females at the Ariy Kamen rookery, a ban was placed on the hunting of these animals; mainly barren animals 1-4 years of age were allowed to be killed, and strict limitations were introduced on the whole because of the decrease in the number of sea-lions on the Commander Isls. Whereas 1910 (58-369) sea-lions were harvested on the islands from1968 to 1977 (an average 191 annually) (Mymrin, Fomin, 1978), only about 290 (3-104) sea-lions were killed over the following ten years up to 1987 inclusively (an average 29 animals annually); beginning in 1982, sea-lions were no longer being utilized as food on animal-breeding farms, and only 79 sea-lions were harvested over a period of 6 years to provide food for the local indigenous population.

Up to the middle of the 1970s, hunting for sea-lions on Ariy Kamen Is. was carried out from January to May, with 3-5 hunting trips a month. During the 1978—1987 seasons, this rookery was visited only 19 times for hunting purposes, and there was no hunting at all on the island in 1982 and 1984.

The conservation measures have not yet had any positive effect on the formation of a sea-lion breeding ground on Ariy Kamen Is., but we can say that this will happen sooner or later. At the present time, sea-lions are encountered here only during the winter—spring period; their numbers decrease to 30-60 by June, and very often there are no sea-lions left on the shore by August.

On the other hand, there are few sea-lions in winter and spring at the neighbouring Severo-Zapadnyi and Yushin rookeries; their numbers increase over the summer, and peak in October—December. By the end of December, the rookeries are completely deserted. Furthermore, 8-10 yearling pups have been appearing with adult animals at the Severo-Zapadnyi rookery over the past few years. The maximum number of pups (17) was noted on 25 November 1987. The origin of these pups was looked into, but it is still an open question, as there were no tagged animals among them. Most likely, the sea-lions noted at this rookery in autumn come from the coast of the Kamchatka Peninsula. To clarify this

and a number of other questions, we must continue to tag the pups on a much larger scale not only on the islands, but beyond their boundaries as well.

In 1985, we tagged two sea-lion pups (both females) at the Manati rookery with red plastic tags, and one male pup at the Yugo-Vostochnyi rookery with a metal tag. In 1987, 20 Manati sea-lion pups (8 males and 12 females) were tagged with metal tags, the kind used in the USSR for tagging fur seals. It should be said that sea-lion pups are less aggressive than fur seals of the same age; when they are being chased, they try to hide behind rocks instead of escaping into the water.

Analyzing the above data, we can say that the number of sea-lions on the Commander Isls has now stabilized at a fairly low level, and amounts to slightly more than 20% of the highest number recorded at the end of the 1970s. At the same time, new harem rookeries have formed, and in the near future we can expect another one on Ariy Kamen Is. The occurrence of miscarried fetuses at the rookeries points to the existence of latent adverse conditions in this part of the sea-lion's range during this period. The mortality rate of adult sea-lions is apparently low, as not more than 10-15 dead animals are found on the islands annually; this cannot have an adverse effect on the total seal-lion stock of the Commander Isls.

The protection of sea-lion rookeries is quite adequate, as some cannot be reached by people, while the others shared with fur seals have conditions similar to those at animal reserves and are more conducive to the growth of abundance. The territory of the hauling-out grounds on the Commander Isls. has unlimited potential for the expansion of sea-lion rookeries. We have not noted any antagonism between these species of eared seals; on the contrary, the sea-lion rookery on Cape Manati has attracted fur seals to the area, and small stable rookeries of bachelor fur seals have begun to form here since 1964 (Pinigin, 1972), and fur seal harems producing up to 15 offspring appreared in 1980—1982 (Vertyankin, Fomin, 1982).

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Brief results of observations on the distribution of sea mammals on the coast of Southern Chukotka and Eastern Kamchatka at the end of June—beginning of July 1987

by V.N. Burkanov (Kamchatrybvod), V.A. Vladimirov (VNIRO) and K.V. Shevlyagin (Glavrybvod)

From 28 June to 11 July 1987, a survey of sea mammals (primarily walruses) was carried out on the "Evekun" medium freezer—trawler along the Chukchi—Kamchatka coast from Cape Navarin in the north to Cape Shipunsky in the south (see map). The work got underway at Cape Navarin (north of this, continuous ice cakes made navigation impossible for a medium freezer—trawler).

Pinnipeds

Walrus. The distribution and abundance of walruses were studied both from the vessel by recording the animals in the water or on the ice (in the northern part of the study area), and by visual counts taken onshore at the hauling-out grounds, or from a boat approaching the shore

within a distance of several tens of metres. Twenty-four walruses were encountered in the zone of diverging ice cakes from Cape Navarin to their southern boundary on the Mayna R. traverse (approximately 50 miles). In most of the cases, the animals were encountered one by one; only in three cases did we come upon groups of two walruses, and in two cases - groups of 3 and 5. Farther south, in the open water, we began to encounter swimming walruses more frequently, and their groups increased to 7-10 and more animals. The largest number of swimming walruses was observed in the Karaginski Gulf, in the area of their hauling-out grounds on Verkhoturov and Karaginski islands. The following five coastal walrus rookeries were inspected in the course of the survey (see map):

- in Dezhnev Bay where approximately 500 animals had hauled out (30 June 1987);

- in Anastasia Bay where about 250 walruses formed two groups (200 in one and 50 in the other) about 100 m away from each other (1 July 1987);

- on Bogoslov Is. in Nataliya—Pavel Bay where 45 walruses formed two small adjacent groups (1 July 1987);

- on Verkhoturov Is. where up to 2800 walruses were noted altogether (2-3 July 1987);

- on Cape Golenishchev, Karaginski Is., where about 500 walruses were counted (3 July 1987).

Distribution of walrus rookeries on the Kamchatka Peninsula at the end of June—beginning of July 1987, and the location of sea-lion rookeries inspected during the expedition:

A - walrus rookeries: 1 - Dezhnev Bay, 2 - Anastasia By, 3 - Bogoslov Is., 4 - "Vodopadnoye", 5 - Cape Galinvilan, 6 - Verkhoturov Is., 7 - Karaginski Is.; B - inspected sea-lion rookeries: I - Cape Vitgenstein, II - Verkhoturov Is., III - Cape Kozlov, IV - Cape Shipunsky

Furthermore, Kamchatrybvod inspectors report that another two walruses rookeries appeared at the same time, on Cape Galinvilan in Korf Bay where more than 1000 animals were recorded, and at the "Vodopadnoye" hauling-out place near Cape Seryi in the Olyutorski Gulf where up to 300 walruses were noted. There were no walruses at the end of June—beginning of July at the other hauling-out grounds on the Burunnykh Isls, in Tyulenye Ozero Bay, on Cape Olyutorski, in Somneniye and Srednyaya bays (Olyutorski Gulf), and on the Semenov sand bar (Karaginski Is.).

A characteristic feature of walrus distribution at the beginning of summer in 1987 was the relatively lower number of animals at the hauling-out grounds in the northern part of the area in comparison with the same period the year before, and the obvious shifting of the main mass of walruses to the southern part of the region, which apparently was due first of all to the much later breakup of the ice on the Chukchi—Kamchatka coast, and secondly, to the more abundant food supply in the southern part of the summer range. A similar distribution of walruses was preserved, by the way, throughout the summer—autumn season. On the whole, the abundance of the walrus in Eastern Kamchatka, estimated at 13,000—15,000 head in 1987, remained at about the same level as in the previous year.

The walruses which congregate in summer at the Eastern Kamchatka rookeries consist almost exclusively of males, among which the older age groups dominate.

Northern sea-lion. Sea-lions have been encountered in this or that number all along the route from the ice edge at Cape Navarin to Cape Shipunsky (southern coast not surveyed). In the zone of diverging ice floes, some sea-lions (mature males and bachelors) were noted both in the water, and on ice floes; farther south, swimming sea-lions were noted mainly in the vicinity of their hauling-out grounds. Surveys were carried out at three bachelor rookeries and at one harem rookery (see map). The following number of males was recorded at the following bachelor rookeries:

- approximately 750, mostly juveniles, on Cape Vitgenstein (2 July 1987);

- about 250 animals of different ages on coastal kekurs in the southern part of Verkhoturov Is. (2 July 1987);

- about 500 males of different ages on rocks off Cape Shipunsky (11 July 1987);

- about 850 animals, including 218 pups (7 of them dead), on Cape Kozlov, the only known harem rookery of the northern sea-lion (10 July 1987);

- 18 and 20 male sea-lions on kekurs of Cape Temnyi and on Kamen Khalaktyrsky respectively.

Though we were unable, unfortunately, to survey all the Eastern Kamchatka hauling-out places of the northern sea-lion, the correlation of our survey results the survey data of previous years has enabled us to establish that the total abundance of this species on the Kamchatka Peninsula is probably at a more or less stable level of about 10,000-15,000 head. At the same time, considering the general tendency towards degradation of the North Pacific sea-lion populations, we believe that a full survey of sea-lion abundance should definitely be conducted in the Kamchatka region in the nearest future.

Harbour seal. The harbour seal was noted constantly all along the route. The frequency of its occurrence and its distribution were close to normal for this season and region, but it was impossible to determine the overall abundance of this species in the waters of Eastern Kamchatka on the basis of the data obtained; this is usually accomplished by means of aerial surveys.

Cetaceans. Reconnaissance observations on the distribution of cetaceans were also conducted along the course (from the top bridge during the daylight hours). In the coastal waters from Cape Navarin to Dezhnev Bay, about 100 grey whales were counted from the spouting and silhouettes on 28-30 June; however, due to a number of factors, including bad weather (turbulence, wind) on one stretch of the course, the given figure is apparently much too low, and can hardly be used to assess the actual numbers of the grey whale in this region. We stopped encountering whales south of Dezhnev Bay. The distribution of grey whales was typical of this region and season. Most of them were encountered singly or in pairs, and only twice did we spot larger groups of 7 and 11 whales; in

three cases, we apparently observed "mother and baby" pairs (two spouts close together, one high and the other much lower). The overwhelming majority of the grey whales seen travelled with frequent diving (apparently feeding) along the coast in a general northeastern direction, keeping mostly to areas with depths up to 20 m; however, a few of the whales stayed in one place and also displayed characteristic feeding behavior. A relatively higher than usual concentration of whales was observed, as always, near the mouths of rivers (some even entering them). Having compared the results of the 1987 observations with those of previous years, we can say that the distribution and behavior of grey whales in this region were, on the whole, identical.

Besides grey whales, three Balaenopteridae identified as finback whales were encountered on the stretch from Cape Navarin to the mouth of the Khatyrka R. On the Zheleznaya Bay traverse (north of Cape Shipunsky), we also encountered a group of 12 killer whales.

The results of our observations and surveys show that the status of these species of marine mammals is quite stable in the Chukchi—Kamchatka region.

Comparative characteristics of the mass of the skeleton and its elements in the harbour seal (*Phoca largha*) and the Kuril seal (*Phoca vitulina stejnegeri*)

by A.Ye. Kuzin (TINRO)

There is very little information about the mass of the pinniped skeleton and its elements in the literature on the skeletal weight characteristics of various orders of invertebrates (Brovar, Leontyeva, 1941; Brovar, 1944; Omura, 1959; Korzhuyev, 1964, 1971; Korzhuyev, Glazova, 1967, 1968; Prange, Christman, 1967; Trotter, Peterson, 1975; Reynolds, 1977; Reynolds, Karlotski, 1977; Andersen et al., 1979; Miyazaki

et al., 1981; Buffrenil et al., 1985; Schmidt-Nielsen, 1985, etc.). Most of this information is presented as reference material on the production of the sea mammal industry (Bryden, 1972; Kosygin, Kuzin, 1979; Kosygin et al., 1985); data on the overall mass of the skeleton of some species of seals as an indicator of the effect of the hypogravitational environment on its inhabitants are given only by P.A. Korzhuyev (1964, 1971) and A.Ye. Kuzin et al. (1973). The weight ratios of the different elements and parts of the skeleton as a whole have not been studied in pinnipeds.

Table 1. Absolute mass of elements of the skeleton (g) and body (kg) in the harbour seal and Kuril seal

Skeletal elements	Harbour seal, n=5		Kuril seal, n=5	
	M	Lim	M	Lim
Skull	341.3	263.0-448.0	664.0	380.0-950.0
Cervical region	174.3	108.0-250.0	256.2	170.0-600.0
Thoracic region	478.7	286.0-800.0	923.0	438.0-1250.0
Lumbar region	197.5	139.0-300.0	488.8	214.0-750.0
Sacral region	124.3	53.5-180.0	180.8	69.0-280.0
Caudal region	48.3	27.2-75.0	90.8	55.2-150.0
Ribs	362.6	230.8-500.0	1270.1	345.8-2250.0
Sternum	74.4	21.0-160.0	153.2	82.0-260.0
Scapula	87.0	52.0-140.0	228.8	66.0-400.0
Humeri	135.0	94.0-202.0	266.0	98.0-460.0
Antebrachia	91.2	52.0-184.0	200.4	96.0-320.0
Manus	115.4	60.0-184.0	167.0	84.0-212.0
Pelvis	149.2	80.0-250.0	296.4	130.0-500.0
Femora	115.2	82.0-166.0	196.2	128.0-300.0
Tibiae	227.0	132.0-340.0	343.6	204.0-500.0
Pedes	356.8	202.0-536.0	507.6	280.0-784.0
Body mass	57.8	22.0-97.0	109.6	51.0-156.0
Body mass/skeletal mass, %	6.0	4.2-10.6	5.9	4.3-7.4
Age, yr		0.5-6.0		1.0-15.0

Material and method. Our material was collected on the Kurile Isls. (table 1). The skeletons of two harbour seals and two Kuril seals were obtained by the method of anatomical preparation; the rest were boiled out over a period of 40-50 minutes, stripped of the muscles and weighed raw. There was practically no difference in the mass of the fresh prepared and the raw boiled out and then cleaned skeletons. The seals were weighed to the kilogram, and the skeletal elements with up to 0.1 g accuracy. The age of the seals was determined by the cement layers of the

teeth (Kleinenberg, Klevezal, 1967). Only one-half of the paired bones of the skeleton was weighed. Their doubled mass is given in the tables.

The author wishes to thank M.K. Maminov and other co-workers for their assistance in collecting the material.

Results and discussion. The data in table 1 confirm published data which state that the relative mass of the skeleton in pinnipeds is smaller than in land mammals. It is believed that the weaker forces of gravitation are responsible for this in all aquatic organisms (Korzhuyev, 1964, 1971).

Table 2. Relative mass of parts of the skeleton and their elements in the harbour seal and Kuril seal

Parts of the skeleton and their elements	% of whole skeleton		% of parts of skeleton	
	Harbour seal	Kuril seal	Harbour seal	Kuril seal
Axial skeleton	58.50	65.07		
	56.44-59.97	61.95-69.11	% of axial skeleton	
Skull	11.08	10.89	18.99	16.82
	9.26-13.16	9.49-13.48	16.36-22.04	14.52-21.77
Spine	33.10	32.05	56.66	49.47
	28.89-35.51	26.61-35.04	48.36-60-59	38.51-54.98
Ribs	12.10	19.68	20.68	29.91
	10.47-15.46	12.43-30.12	17.55-25.88	20.06-43.58
Sternum	2.16	2.44	3.71	3.77
	1.09-3.48	2.20-2.87	1.82-4.43	3.26-4.64
Peripheral skeleton	41.50	34.93	% of peripheral skeleton	
	40.03-43.36	30.89-38.05		
Forelimbs	13.75	13.26	33.14	37.92
	12.10-15.45	12.05-14.12	27.91-35.46	31.67-41.21
Girdles	2.74	3.44	6.63	9.64
Free limbs	10.99	9.82	26.51	28.28
	10.21-12.41	9.04-10.52	22.55-28.47	25.00-30.76
Hind limbs	27.73	21.67	66.91	61.86
	25.85-31.25	18.63-25.99	66.29-72.08	58.79-68.32
Girdles	4.67	4.54	11.36	12.96
Free limbs	22.05	17.13	55.55	48.90
	21.51-27.11	15.30-21.44	52.05-62.53	44.49-56.35

The ratio of the mass of the axial skeleton to the mass of the peripheral skeleton varies in different species of mammals (Brovar, 1944; Svechkin et al., 1967; Bogolyubsky, 1968; Ninov, Khrustaleva, 1985). In the true seals studied by us (table 2) and other researchers (Bryden, 1972), the axial skeleton prevails. The limbs of the true seals are exposed to practically no bearing load during statolocomotion on land or on ice. The axial skeleton takes this function upon itself. Therefore, in the Kuril seal, as in any animal with greater gravitation to land, the axial skeleton is relatively heavier than in the harbour seal (table 2). In the axial skeleton itself, the relative mass of the ribs, which perform the shock absorbing and respiratory functions, is greater in the Kuril seal as compared with the harbour seal.

The Kuril seal has a larger body mass than the harbour seal (table 1). However, the relative mass of the peripheral skeleton is greater in the harbour seal (table 2), which is inconsistent with the results obtained in a study of the skeleton of land mammals in which the relative mass of the supporting parts of the skeleton is determined mainly by the body mass (Schmidt-Nielsen, 1987). This also goes against the logical relationships between the mass of the axial skeleton and the mass of the peripheral skeleton in marine mammals, according to which species less specialized to an aquatic mode of life should have a higher relative mass of the peripheral skeleton. In dophins, for example, the relative mass of the peripheral skeleton is even smaller than in pinnipeds (Buffrenil et al., 1985). A compromise here would be to examine the mass ratio of the bones in relation to their loads which appear when they must overcome the forces counteracting statolocomotion, regardless of the animals' environment.

In the axial skeleton, the relative mass of the skull and spine as a whole is greater in the harbour seal; the same holds true for the cervical, pectoral and sacral regions of the spinal column itself (see table 2). The relative mass of the lumbar and caudal regions was practically identical in both species (table 3). At the same time, when calculating the mass of the different parts of the spinal column against its total mass with and without the skull, the observed differences in the values of the relative mass of the skull and the cervical, pectoral and caudal regions, derived

from the ratio of their masses to the mass of the whole skeleton or its peripheral region, level off, while the relative mass of the lumbar region becomes significantly predominant in the Kuril seal. Therefore, having determined that the relative masses of the various parts of the spine differ in the Kuril and harbour seals, the main differences are noted mainly in the locomotory parts of the spine. Therefore, we have every reason to assume that the contribution of the caudal regions of the body to locomotion differs in the harbour and Kuril seals, though this is difficult to determine visually.

Table 3. Relative mass of the skull and parts of the spinal column in the harbour and Kuril seals

Indices	Harbour seal		Kuril seal	
	M	Lim	M	Lim
% of axial skeleton				
cervical	9.69	8.87-10.97	8.57	6.84-9.61
pectoral	25.95	21.57-26.33	22.49	17.74-25.36
lumbar	11.28	7.71-13.16	11.73	9.03-13.23
sacral	7.03	6.10-9.43	4.34	3.11-6.66
caudal	2.67	2.37-2.94	2.37	1.77-3.12
% of spine with skull				
skull	25.14	21.27-31.30	25.39	22.48-28.92
cervical	12.83	11.89-14.06	12.99	11.81-14.88
pectoral	34.32	30.64-41.33	33.90	32.90-35.97
lumbar	14.89	10.34-16.93	17.71	16.07-18.65
sacral	9.24	5.46-12.26	6.51	5.18-9.39
caudal	3.54	3.03-3.87	3.45	2.21-4.14
% of spine without skull				
cervical	17.23	15.48-20.14	17.43	15.23-19.48
pectoral	45.81	43.19-53.87	44.88	43.29-47.62
lumbar	19.94	13.46-22.12	23.72	22.61-24.35
sacral	12.26	7.95-15.58	8.28	5.18-12.12
caudal	4.75	4.01-5.65	4.49	2.21-5.83

In the peripheral skeleton, the mass of the skeleton of the forelimbs to the mass of the whole skeleton is approximately the same in both species of seals, while the relative mass of the skeleton of the hind limbs is greater in the harbour seal (see table 2). The girdles of the limbs of the seals had practically the same relative mass, while the relative mass of the bones of the free limbs, especially the hind ones, is greater in the harbour seal. When comparing the same parts of the skeleton of the limbs, calculated against the mass of the peripheral skeleton, we found that the relative mass of the skeleton of the forelimbs was greater in the Kuril seal, while the relative mass of the hind limbs remained predominant in the harbour seal (table 2).

The harbour seal has stronger ecological ties with the water. Perhaps this is why the relative mass of the skeleton of the hind limbs as the main propelling organ is greater in the harbour seal than in the Kuril seal. In turn, the more massive Kuril seal is characterized by a higher relative mass of the skeleton of the forelimbs.

The weight and linear size of certain bones of the limbs are greatly influenced not only by the forces of the active muscles, but also by the direction of the static and dynamic loads which either coincide with the long axis of the bones and then their parameters increase, or are directed at an angle to the long axis of the bones and then the growth of the latter slows down (Manziy, Moroz, 1978).

In the forelimbs of these two seals, the mass of the scapulae, humeri and antebrachial bones of the peripheral skeleton is relatively greater in the Kuril seal, while the skeleton of the manus has a greater mass in the harbour seal (table 4). The same indices derived from a comparison of the above-mentioned bones and the appendicular skeleton have changed very little, though the relative mass of the humeral bones has become slightly greater in the harbour seal (see table 4).

The skeleton of the hind limbs in relation to the peripheral skeleton is heavier in the harbour seal than in the Kuril seal. At the same time, the relative mass of the tibia and foot is significantly greater in the first species, while the mass of the pelvis is slightly greater in the second. The mass of the femora is practically the same in both species. A similar bone

mass ratio of these limbs is also noted when their mass is compared with the overall mass of the appendicular skeleton (table 4).

Table 4. Relative mass of elements of the appendicular skeleton in the harbour and Kuril seals

Indices	Harbour seal		Kuril seal	
	M	Lim	M	Lim
Forelimbs				
% of peripheral skeleton				
scapulae	6.63	5.36-7.98	9.64	6.07-11.54
humeri	10.67	10.05-12.23	11.59	9.02-12.64
antebrachial	6.91	5.06-9.19	8.93	7.79-9.83
manus	8.90	5.78-11.73	7.92	5.77-9.74
% of appendicular skeleton				
scapula	19.96	16.50-23.97	25.06	19.18-28.98
humeral	31.12	28.45-36.03	30.24	28.48-33.33
antebrachial	20.88	15.20-25.91	23.63	19.64-27.90
manus	26.72	20.72-34.92	20.93	14.49-24.56
Hind limbs				
% of peripheral skeleton				
pelvis	11.26	9.55-12.98	12.96	11.97-14.43
femoral	9.15	8.29-10.67	9.36	7.29-11.78
tibiae	18.48	16.32-24.80	16.10	13.42-18.78
feet	27.86	26.30-30.41	23.41	21.14-25.78
% of appendicular skeleton				
pelvis	17.49	13.25-22.39	21.06	17.52-23.99
femoral	14.11	12.79-16.53	15.07	12.41-17.25
tibiae	27.48	24.59-34.42	25.96	22.83-28.94
feet	41.75	39.53-45.81	37.88	34.22-40.85

The supporting function of the skeleton of the forelimbs in true seals is not as significant as in land and amphibious mammals. In seals, they are used mainly as holdfast organs that keep the anterior part of the body in a static position when the posterior part is extended as the animals moves over a hard substrate. Nevertheless, both species of seals have the same distribution of forelimb bone mass as in land mammals (Manziy, Moroz,

1978). The interspecific differences in the relative mass of individual skeletal elements of the forelimbs of these seals are determined by different body dimensions.

The hind limbs in true seals are the main propelling organ in water. They are incapable of folding under the body, they do not contribute to the animal's movement over land or ice, and because of this, they are not exposed to static loads. Therefore, the distribution of the bones by mass in the hind limbs of true seals differs from that in land mammals. The relative mass of the limb bones in seals increase from the stylopodia to the autopodia, while the reverse is observed in land mammals. It would seem that the distal regions of the hind limbs of the harbour seal, which surpasses the Kuril seal in the relative mass of the autopodial bones, are exposed to a greater functional load. In turn, the whole posterior part of the body is apparently of greatest importance to locomotion in the Kuril seal; it has more strongly developed hypaxial—epaxial muscles, some of which are attached to the strong ridges and heads of the iliac bones, and it is the massiveness of the latter that determines the higher than usual relative mass of the pelvis in these species.

Therefore, the data obtained on the relative mass of the whole skeleton of the Kuril seal and the harbour seal are similar, and lie within the framework of the data on other pinnipeds. The body mass in true seals is not the determining factor in either its ratio to the skeleton, or the ratio of the mass of the axial skeleton to the mass of the peripheral skeleton. In the harbour seal, which is smaller but trends more strongly to a pelagic mode of life, the relative mass of the skeleton is equal to that of the Kuril seal, while the relative mass of the peripheral skeleton is greater than that of the Kuril seal. It appears that the relative mass of individual bones, regions and the skeleton as a whole is determined by the statodynamic loads that appear as a result of the forces counteracting statolocomotion, regardless of the environment inhabited by the animals. No strong correlation is noted in the ratio of the girdles and free limbs, or in the limbs and topographically linked regions of the axial skeleton, due to the fact that seals are biologically capable of living on land or on ice, and swimming in the water.

The most significant differences between the harbour seal and the Kuril seal are observed mainly in the skeletal elements and parts of the skeleton that contribute directly to locomotory activity. The dynamic loads underlie these differences; the extent of these dynamic loads is determined by the overall size of the animals, the proportions and hydrodynamic properties of the body, and, possibly, by the imperceptible specificities of their locomotion.

The harbour and Kuril seals belong to the same genus, *Phoca* , and have the same ancestral animal prototype. Because of this, we can justifiably say that all the morphological characters noted in the present-day species were formed under the effect of environmental conditions, and, via a system of correlations, developed into concrete morphological complexes that meet the requirements of their optimal ratio in the organism.

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IV. STUDY OF THE SEA-OTTER

Population structure of the sea otter (*Enhydra lutris*) of the Kamchatka Peninsula and the Commander Islands

by A.M. Burdin (Kamchatka branch of TINRO)

The sea otter (*Enhydra lutris*) is the only member of the marten family (Mustelidae, Carnivora) that leads a marine mode of life. The range of this species takes in a large part of the North Pacific coast of both the Asian and American continents. However, despite the fairly extensive data available on the various aspects of the species' biology, particularly from recent years, one of the fundamental questions, the population structure of the species, has not yet been researched well enough. The Soviet literature contains only general comments (Maminov, 1985) regarding the presence of at least three sea-otter populations on the Kurile Isls., but this, unfortunately, has not be confirmed by facts. As to the groupings of sea-otters inhabiting the northwestern part of the range in the USSR (including the Kamchatka region), they still have not been differentiated in a formal investigation.

A number of investigations has been carried out in the American part of the range; they dealt with questions pertaining to the intraspecific systematics of the sea otters inhabiting the NE Pacific, but they did not discuss the population structure of this species in the highly extensive American part of the range (Roest, 1979; Davis Lidicker, 1975).

Nevertheless, it has now become extremely important to distinguish the local populations of the sea otter, since without this, it is difficult to work out effective measures for the protection and rational utilization of this most valuable species.

In the northwestern part of the Pacific Ocean, we currently observe active regeneration of the historical range of sea otters, occupied by them up to the onset of their exploitation in the 18th century, which was followed by an increase in the abundance of its groupings (Burdin,

Sevostyanov, 1985). This process became particularly intense during the past decade, when the sea otter populated Bering Is. after more than 100 years (Mymrin et al., 1972; Mymrin, 1975). A grouping of sea otters appeared in the vicinity of the Kronotsky Peninsula in Kamchatka (Vershinin, Khromovskikh, 1977), and there was a significant increase in the numbers of these animals on the Kurile Isls. (Kuzin et al., 1984; Maminov, 1985) and in the southern part of Kamchatka.

This growth in the abundance of sea otters and their dispersal raised a number of questions having to do with research into the restoration of the range, the influx of migrants, and their role in the formation of the present-day population structure of this species on the Commander Isls. and the Kamchatka Peninsula.

In connection with this, we undertook to determine the status of the sea-otter groupings inhabiting the northwestern part of the range in the USSR, based on morphometric analysis of the skulls.

Material and method. A collection of sea otters from the Commander Isls, Cape Lopatka and the Kronotsky Peninsula is analyzed here. I was assisted in the collection of the material by V.F. Sevostyanov and I.A. Lipilina of the Commander Isls. Scientific Station of VNIRO, V.N. Burkanov, V.V. Vertyankin, V.S. Nikulin and V.V. Fomin of Kamchatrybvod, hunter I.A. Krivolapov, as well as workers of the Kronotsky Reserve, to whom I am deeply grateful.

Over 500 skulls were examined in all, but only those of adult sea otters were used to determine population differences. Age was determined by a number of characteristics, namely the condylobasal length of the skull, the degree of development of the cranial ridges, and the degree of fusion of the interosseous sutures.

Since the mortality of male sea otters is significantly higher than that of females under natural conditions, we did not have many female skulls; therefore, only the measurements of male skulls were analyzed. This approach excluded the effect of sex and age variability on the results of our study.

The slight discrepancy in the number of skulls used to analyze individual characteristics is due to the fact that some of the skulls had certain defects (absence of a lower jaw, broken bones, etc.), which made it

impossible to include them in the analysis. The measurements were carried out with an accuracy of up to 0.1 mm.

The following measurements were used to determine the population differences in the linear size and proportions of the skull:

1) the condylobasal length of the skull;

2) the length of the hard palate (from the inner margin of the central incisor sockets to the margin of the palatine notch (without the process if one was present);

3) the length of the facial part (from the anterior margin of the central incisor sockets up to the line of least postorbital compression);

4) the length of the cerebral part (from the line of least postorbital compression to the most protruding part of the occipital condyle);

5) the length of the suture of the nasal bones;

6) the mastoid width of the skull;

7) the zygomatic width of the skull;

8) the smallest width of the hard palate behind the row of teeth;

9) the smallest width of the postorbital compression;

10) the length of the upper row of molars;

11) the length of the eardrum;

12) the width of the eardrum;

13) the height of the eardrum;

14) the length of the lower jaw;

15) the height of the lower jaw between PM_3 and M_1;

16) the width of the coronoid process of the lower jaw in the middle.

The arithmetical mean (M), the standard deviation (m) and the coefficient of variation (CV) were calculated for each characteristic. The t-test was used to determine the confidence level of the differences, which was calculated for each characteristic as well.

Results. By analyzing the measurements of the skulls of male sea otters from the four local groupings inhabiting Bering Is., Mednyi Is., Cape Lopatka and the Kronotsky Peninsula, we were able to distinguish two distinct populations in which the deviations in both the linear size and proportions of the skull were minimal. These are the groupings of sea otters that make up the Commander Isls. population (from Bering Is. and Mednyi Is.) and the Kamchatka population, which are localized in the

southern (Cape Lopatka) and central (Kronotsky Peninsula) parts of Kamchatka. Table 1 contains the data on the 16 skull measurements carried out in adult male sea otters; the confidence level of the differences between the skull samples for each characteristic is recorded in table 2.

As we can see from table 1, the sea otters of the Kronotsky grouping have the largest skull measurements, and those of Mednyi Is. the smallest. This tendency is characteristic of the majority of the 16 characteristics analyzed. At the same time, the skull proportions characteristic of the Kamchatka and Commander Isls. populations are also observed in the Kronotsky and Mednyi sea otters. For example, with a relatively stable zygomatic width (differences insignificant for all the samples compared), the mastoid width of the skull in the sea otters of the Kamchatka and Commander Isls. populations is the same in the Kronotsky and Mednyi Is. groupings. For example, with a relatively stable zygomatic width (differences insignificant for all the samples compared), the mastoid width of the skull in the sea otters of the Kamchatka population is significantly greater ($P>0.001$) than in the Commander Isls. population, and constitutes 98.6 ± 0.3127 and 103.9 ± 0.3439 for the most representative samples from Bering Is. and Cape Lopatka respectively. The derived ratios of zygomatic and mastoid width (M_w/Z_w) have shown that this index is greater or equal to 1 for the skull samples from the Kamchatka population (Kronotsky and Lopatka groupings), and is equal to 0.9 for the Bering Is. and Mednyi Is. groupings of the Commander Isls. population.

In the facial part of the skull, the most significant differences between the populations were noted in the length of the suture of the nasal bones. Despite the quantitative difference of the samples representing each population, the length of the suture of the nasal bones for each of them is stable, and constitutes 18.6 mm for the Commander Isls. ppopulation (both for Bering Is. and Mednyi Is.), 20.1 mm for the Lopatka grouping of the Kamchatka population, and 20.3 mm for the Kronotsky grouping of the same population.

The Commander Isls. population displays less variability in the height of the eardrums as well (see tables 1 and 2). Despite the fact that the differences in this characteristic between the numerous skull samples from Cape Lopatka and the Commander Isls. populations are highly

significant (P>0.001), the Kronotsky grouping comes close to the Commander Isls. population and differs from the Lopatka population (P>0.05) in this characteristic, although none of the samples differed significantly in the other criteria characterizing the eardrums (width, among other things). The width of the eardrums can apparently be placed in the category of conservative characteristics which are not subject to populational variability.

Of the three lower jaw criteria, only the width of the coronoid process differed significantly in the populations. The increase in the width of the coronoid process in the sea otters of the Commander Isls. population is the result of the distinctive convex or straight form of the posterior margin, whereas a notch forms on the posterior margin of the coronoid process in the Kamchatka population.

Analysis of the measurements has shown that the most conservative characteristics of the skull in sea otters, apart from the width of the eardrums, are those related to the bony base of the mouth, i.e. the length of the hard palate and the length of the upper row of molars. The differences between all the four samples are insignificant in these criteria. The width of the hard palate behind the row of teeth is smaller in the skulls from Mednyi Is., which differ significantly (P>0.05) from the other samples, including the one from Bering Is. The rest of the samples do not differ in this criterion.

The observed differences in the skull proportions of the male sea otters from different populations clearly illustrate the polygons of distribution of the absolute values of certain characteristics (Fig. 1, 2).

It is not difficult to see that each of the populations has its own characteristic proportions, and the general configuration of the polygons (Fig. 1) reflects the form of the skull, regardless of the differences in the absolute values of some criteria in sea otters from different groupings. Furthermore, the variability of the criteria with the greatest differences, depicted in a three-dimensional polygon (Fig. 2), also shows that each of the four groupings of sea otters belongs to a specific population.

Table 1. Measurements of skulls of male sea otters from different groupings

Criterion	Bering Is.				Mednyi Is.		
	n	M±m	lim	CV	n	M±m	lim
1	155	135.6±0.3518	114.6-145.5	3.2	12	134.0±0.09941	128.2-138.4
2	160	58.8±0.1679	48.8-63.6	3.6	12	58.3±0.5703	53.8-60.8
3	161	79.6±0.3142	63.0-89.7	5.0	12	78.9±1.1360	73.1-84.8
4	155	96.2±0.2140	82.3-102.2	2.7	12	95.5±0.7936	90.4-99.9
5	158	18.6±0.1317	13.8-23.5	8.9	11	18.6±0.6403	14.8-22.3
6	159	98.6±0.3127	80.2-107.4	3.9	12	97.5±1.2563	91.0-105.6
7	154	104.8±0.3245	86.4-116.4	3.8	11	103.7±1.1583	98.2-110.0
8	161	25.8±0.0903	21.4-29.0	4.4	12	25.0±0.3324	23.1-26.6
9	161	30.6±0.1605	23.2-39.3	6.6	12	29.9±0.4302	27.3-32.7
10	159	35.3±0.0962	32.3-39.0	3.4	12	35.2±0.3867	33.5-37.5
11	159	33.8±0.1275	27.2-38.0	4.7	12	33.7±0.4571	31.5-36.5
12	160	18.1±0.0567	16.3-19.8	3.9	12	18.0±0.1361	17.3-18.8
13	156	92.3±0.2508	77.0-99.8	3.3	12	91.1±0.8670	85.4-94.4
14	157	18.1±0.0843	14.4-20.5	5.8	12	17.9±0.3503	15.8-19.7
15	156	25.5±0.1194	20.0-29.9	5.8	12	25.2±0.4893	22.0-27.4
16	161	6.9±0.0491	5.3-8.3	9.0	11	6.9±0.2143	6.1-8.3

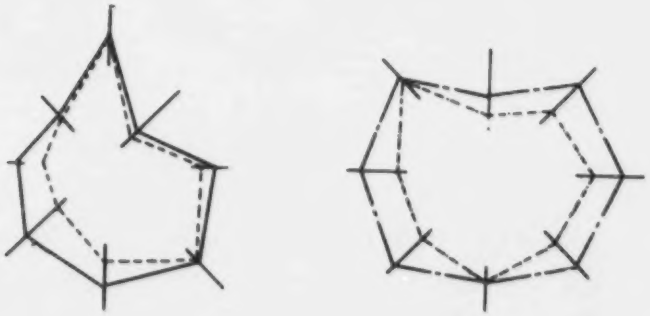

Fig. 1. Polygons of distribution of the absolute values of some skull characteristics of sea otters from the Kamchatka and Commander Isls. populations:
—— Bering Is.; ----- Mednyi Is.; -·-·- Cape Kronotsky; -··-··- Cape Lopatka

in the northwestern part of the USSR range, mm

Cape Lopatka				Cape Kronotsky				
CV	n	M±m	lim	CV	n	M±m	lim	CV
2.5	108	135.8±0.333	126.2-143.5	2.5	11	137.5±0.6027	135.4-141.2	1.4
3.3	108	58.7±0.1712	52.7-65.6	3.0	12	59.4±0.6682	54.3-62.4	3.8
4.9	108	79.8±0.3029	72.1-93.7	3.9	12	82.3±0.8164	75.3-85.5	3.4
2.8	108	98.1±0.2228	87.3-102.4	2.3	11	97.7±0.7909	91.6-100.5	2.6
11.3	108	20.1±0.1448	16.9-24.3	7.4	12	20.3±0.3775	18.1-23.5	6.4
4.4	108	103.9±0.3439	93.0-113.8	3.4	11	107.3±1.1403	99.8-111.2	3.5
3.7	108	104.1±0.3523	94.7-112.7	3.5	11	105.5±0.7910	101.4-109.4	2.4
4.6	108	25.9±0.1481	23.1-25.5	5.9	12	26.0±0.3454	23.7-27.7	4.6
4.9	108	31.3±0.1441	27.7-34.8	4.6	12	31.0±0.3454	27.8-33.5	5.6
3.8	108	35.1±0.1153	30.9-37.9	3.4	12	35.0±0.4387	31.4-37.0	4.3
4.7	108	33.9±0.1544	30.0-38.0	4.7	11	34.7±0.2997	33.2-36.2	2.8
2.6	108	17.8±0.0716	16.0-19.3	4.1	11	18.1±0.2515	16.9-17.8	4.6
3.2	108	91.8±0.2360	83.7-98.9	2.6	10	93.0±0.7556	17.1-19.6	4.4
6.7	108	18.4±0.0999	16.0-20.6	5.6	10	18.4±0.2602	87.3-95.9	2.5
6.7	108	23.4±0.1225	19.5-26.6	5.4	10	24.0±0.6017	20.1-26.1	7.9
10.2	107	5.9±0.0650	4.1-7.8	11.4	12	6.6±0.2541	5.4-8.0	13.4

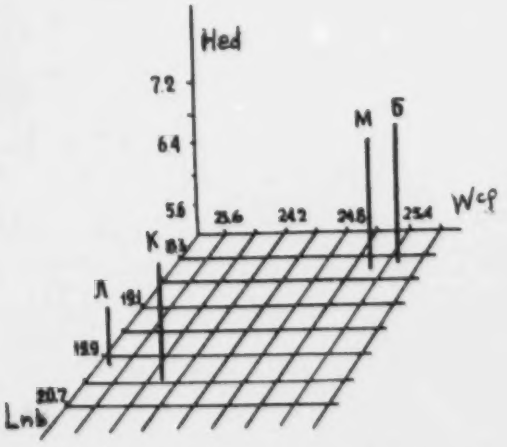

Fig. 2. Differences in the absolute values of skull measurements in male sea otters: L - Cape Lopatka, K - Cape Kronotsky, M - Mednyi Is., B - Bering Is. Lnb - length of nasal bones, Hed - height of eardrums, Wcp - width of coronoid process

Table 2. Significance of differences in the skulls of male sea otters from four local groupings (t-test)

	Bering Is.			Cape Lopatka		Kronotsky Peninsula
	Mednyi Is.	Cape Lopatka	Kronotsky Pen.	Mednyi Is.	Kronotsky Pen.	Mednyi Is.
1	1.43	0.55	2.8	1.7	2.4	2.98
2	0.85	0.47	0.8	0.66	1.0	1.23
3	0.62	0.45	3.08	0.79	2.8	2.45
4	0.85	6.0	1.8	3.1	0.49	1.93
5	0.1	7.68	4.3	2.2	0.5	2.23
6	0.88	11.4	7.3	4.9	2.8	5.78
7	0.89	1.58	0.8	0.25	1.7	1.26
8	2.36	0.38	0.4	2.4	0.23	2.02
9	1.44	3.13	0.67	2.9	0.6	1.53
10	0.19	1.38	0.69	0.32	0.22	3.99
11	0.30	0.9	2.7	0.7	2.1	1.92
12	0.93	0.4	0.3	1.5	1.2	2.34
13	1.41	1.5	0.8	0.8	1.5	1.69
14	0.59	2.06	0.96	1.3	0.25	1.09
15	0.49	12.0	2.4	3.6	0.9	1.61
16	0.17	12.18	1.08	4.6	2.7	0.96

Discussion. A comparative analysis of sea-otter skulls has enabled us to establish the origin of recent groupings of sea otters, specifically the Bering and Kronotsky groupings. The appearance of these groupings was first mentioned at the beginning of the 1970s, when sea otters began to appear on Bering Is. and near the Kronotsky Peninsula (Mymrin et al., 1972; Mymrin, 1975; Vershinin, Khromovskikh, 1977). However, nobody knew exactly where they came from. While it was logical to assume that the Bering grouping had migrated to this area from Mednyi Is. where the numbers of these animals had reached the maximum level by the 1970s (Sevostyanov, Burdin, 1987), the source of the Kronotsky grouping of sea otters was unclear. The only paper to raise this question (Vershinin, Khromovskikh, 1977) is of a hypothetical nature. The appearance of the Kronotsky grouping is attributed to the influx of migrants from the Commander Isls. as a result of currents and drifting ice. On the basis of these assumptions, subsequent descriptions of the areas of distribution of the generally accepted subspecies of the sea otter in the USSR (Red Book of the RSFSR) placed the Kronotsky grouping in the northern subspecies of

the sea otter (*E. l. lutris*), the range of which included not only the Commander Isls., but also the central part of the Kamchatka Peninsula. The range of the other subspecies (*E. l. gracilis*) was localized (as indicated in this publication) only in the southern part of the Kamchatka Peninsula and on the Kurile Isls.

Table 3. Mean values and standard deviations in the condylobasal length of the skull and the length of the suture of the nasal bones in male sea otters from various parts of the range, mm

Area of occurrence	Ref.	Length					
		condylobasal of the skull			suture of the nasal bones		
		n	M	CV	n	M	CV
Cape Lopatka	our data	108	135.8	3.5	108	20.1	1.5
Cape Kronotsky	our data	11	137.5	1.4	12	20.3	6.4
Bering Is.	our data	155	135.5	4.4	158	18.6	1.7
Mednyi Is.	our data	12	134.0	3.4	11	18.6	2.1
Amchitka Is.	Roest, 1979	38	135.5	3.3	38	16.1	1.9
Adakh Is.	Roest, 1979	17	137.8	3.7	17	17.6	1.2
Northern Pen.	Roest, 1979	7	137.0	1.7	7	19.7	1.1
Southern Pen.	Roest, 1979	6	138.7	2.6	6	19.5	2.1
Kenai Pen.	Roest, 1979	4	138.5	2.1	4	20.1	0.3
Prince William Sound	Roest, 1979	13	134.5	3.3	13	19.3	1.3
British Columbia	Roest, 1979	3	138.7	0.6	3	19.4	3.1
Washington and Oregon	Roest, 1979	3	132.3	4.1	3	18.8	1.0
California	Roest, 1979	33	130.8	3.7	33	19.3	1.3

Nevertheless, our analysis of skulls has shown that the similarily between the sea otters found near the Kronotsky Peninsula and those in the southern part of the Kamchatka Peninsula is far more obvious than the similarity between the Kronotsky sea otters and the Commander Isls. sea otters, which, in turn, indicates that the southern Kamchatka grouping is the source of the Kronotsky grouping. From this we can conclude that the whole of the Kamchatka Peninsula is inhabited by sea otters of the same subspecies. Similar data were also obtained during analysis of the samples based on the phenetic characters of the skull and the colour of the fur; the results of this analysis is discussed separately.

Having a large number of sea-otter skull samples in our collection, we believed it would be possible to compare our measurements of the skull with the data on the American part of the range, presented by A. Roest (1979).

Unfortunately, we managed to compare them only in two criteria, the condylobasal length of the skull and the length of the suture of the nasal bones. When analyzing the material in table 3, it is easy to see that the most abundant samples (Bering Is., Cape Lopatka, Amchitka Is.) are practically identical in the condylobasal length of the skull. At the same time, as the sample diminishes, the standard deviation (135.5 mm in the given case) in this or that direction increases. In all probability, all the tabulated measurements of the condylobasal length of the skull in sea otters from different groupings (with the exception of the Californian grouping) should approximate the mean value when analyzing more representative samples.

It is quite possible that the differences observed by us in the linear size of the male skull (larger in the Kronotsky sea otters) are also the result of a small number of samples, and will level off when more extensive material is analyzed. However, it is difficult to prove this at the present time. Nevertheless, a comparison of representative samples has shown that the condylobasal length of the skull in the sea otter cannot be regarded as a differentiating character, at least not at the population level.

For example, the condylobasal length of the skull in male sea otters from Bering Is., Cape Lopatka, Amchitka Is. and Prince William Sound differs insignificantly. The male sea otters from Alaska (Southern Peninsula) and British Columbia can be combined in another group. Such groupings are inconsistent with the "cline" concept which implies gradual change of a character in a specific direction. In our opinion, the measurements of the sutures of the nasal bones given in table 3 do not reflect clinal variability either, although the samples fall into neat groups where this character is concerned (unlike the condylobasal length of the skull), and are more likely to reflect the populational structure of the species. For example, the lowest value of this character is noted in the sea otters inhabiting Akakh Is., and the highest value is observed in the sea otters of the Kamchatka population (Cape Lopatka, Kronotsky Peninsula)

and the Kenai Peninsula. The sea otters of the Commander Isls. population can be placed in the same group as the Washington and Oregon sea otters on the basis of this character, i.e. the latter varies without any particular uniformity, thus indicating a mosaic populational structure of the species, rather than clinal variability as stated by Roest (1979).

The difficulties encountered when studying the variability of skull size are explained to some extent by O.L. Rossolimo (1979) who, in a study of a large number of wide-range species, has shown that the greater the effect of various climatic factors, the wider the skull-size variability of a species. Despite its considerable expanse, the greater part of the range of the sea otter is located in relatively uniform environmental conditions. Based on O.L. Rossolimo's conclusions, one can assume that the variability of the skull size in sea otters will vary insignificantly in the part of the range that lies between 50° and 60° N lat. and takes in the shores of the northern islands of the Kurile chain (Shumshu and Paramushir islands), the Kamchatka Peninsula, the Commander Isls., the Aleutian Isls., Alaska, and the Pacific coast of Canada (Washington and Oregon).

Summary

1. Morphometric analysis of the linear size and proportions of the skull in sea otters has shown that two independent populations, the Commander Isls. population and the Kamchatka population, inhabit the northwestern part of the USSR range.

2. The Commander Isls. population consists of two groupings, the Bering Is. and Mednyi Is. groupings. The Bering Is. grouping of sea otters is the younger one; it began to form at the beginning of the 1970s, after a lengthy absence of sea otters on this island. It was formed by migrant sea otters from Mednyi Is., the influx of which was particularly strong during 1979—1982. From then on, the Bering grouping increased on its own reproductive potential (Burdin, Sevostyanov, 1986).

3. The Kamchatka population also consists of two groupings, but these are located far from each other. One has existed since the 1970s in the vicinity of the Kronotsky Peninsula, and the other is localized in the southern part of the Kamchatka Peninsula with a range covering the

Northern Kuriles as well. The Kronotsky grouping was formed by migrant sea otters from southern Kamchatka.

4. The greatest distinguishing differences in the size and proportions of the skull between the Kamchatka and Commander Isls. populations of sea otters are noted in the following characters: the mastoid width of the skull, the length of the suture of the nasal bones, and the width of the coronoid process of the lower jaw.

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Some results of the tagging of sea otters on the Commander Isls. during 1986—1987

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As we begin to analyze the present status and future development of the population of sea otters, we must take into consideration that we cannot yet control the dynamics of its demographic parameters in a number of objective circumstances (sexual and age dimorphism weakly defined, no commercial removal, scientific take based on culling of old and sick individuals).

In the given situation, the best way to overcome these difficulties is to develop effective methods of tagging sea otters.

Until recently, sea otters were captured in summer by means of large-mesh fixed gillnets; the fur of the trapped animals was very quickly damaged in the process, and the soaked sea otters soon died of supercooling.

Our investigations were conducted on Bering Is. together with the Commander Isls. inspection of Kamchatrybvod. The sea otters were captured at the coastal winter rookeries with the help of nets. The standard fur-seal tag was attached to the right hind flipper of the males, and to the left one of the females. A plastic plate of different colours (red, white, yellow, etc.) was attached to the tag, depending on the tagging area. This made it much easier to count the tag codes.

In 1987, sea otters were tagged only on Bering Is. (see diagram). From December 1986 to April 1987, 255 sea otters were tagged in all, 235 (92.2%) of them at the permanent coastal rookeries, and 20 (7.8%) at some distance from the rookeries (table 1).

Cape Severo-Zapadnyi [literally Northwestern], about 24 km from Nikolskoye village, was the most convenient place for tagging sea otters in 1987. Here, the sea otters form a reef rookery with up to 350 animals, which is accessible during low tides, as well as a coastal rookery with up to 150 animals, which can be easily reached during high tides. The

unevenness of the shore line and the wide coastal zone provide good conditions for tagging. 57.3% of all the animals used in this study were tagged here (table 2).

Table 1. Age and sex composition of the sea otters tagged on Bering Is. (December 1986—April 1987)

Indices	Males			Females			
	ad	subad	juv	ad without pups	ad with pups	subad	juv
No. of sea-otters tagged	197	21	2	17	3	16	1
% of total number tagged	77.3	8.2	0.8	6.7	1.2	6.3	0.4

Occurrence of sea otters tagged at the coastal rookeries of Bering Is. during 1984—1987, based on tag-return data

● - male sea-otter rookeries; o - predominantly female rookeries; [I] - tagging site; I - place of encounter of tagged sea otters

Table 2. Age and sex composition of sea otters in tagging area on Bering Is. in 1986—1987

Place of tagging	Sea otters tagged												Total n	%
	Males				Females				Pups					
	ad	%	subad	%	ad	%	subad	%	♂♂	%	♀♀	%		
Northwestern rookery	130	89	10	69	4	27	2	14	-	-	-	-	146	57.3
Cape Tolstyi (rookery)	40	95.2	1	2.4	1	2.4	-	-	-	-	-	-	42	16.5
Northern rookery	23	67.7	2	5.9	6	17.6	1	2.9	-	-	2	5.9	34	13.3
Nepropusk rookery	2	15.4	1	7.7	9	69.2	-	-	1	7.7	-	-	13	5.1
Total at rookeries	195	83	14	6.0	20	8.5	3	1.3	1	0.4	2	0.8	235	92.2
Outside rookeries	2	10	7	3.5	-	-	11	55	-	-	-	-	20	7.8
Total on Bering Is.	197	77.3	21	8.2	20	7.8	14	5.5	1	0.4	2	0.8	255	100

The coastal rookery on Cape Tolstyi is considered to be the largest on Bering Is. Up to 600 sea otters have been counted here during certain years. Just as at the northwestern rookery, the animals during low tide form reef congregations which are inaccessible for tagging. The narrow coastal strip and the absence of natural shelters for trappers make the tagging process very difficult. Only 16.5% of the sea otters were tagged here. Most of these animals are solitary, old and sick individuals, which accounts for the high mortality here.

The tagging conditions at the northern sea-otter rookery are similar to those at the northwestern one. Here the sea otters form approachable congregations of up to 150 head on reefs and on the shore. However, during the winter of 1986/87, only 13.3% of the animals were tagged here by the Commander Isls. inspectors of Kamchatrybvod.

Even less convenient for sea-otter tagging is the rookery on Cape Nepropusk; for three years now, it has been located 200 m from the residential boundary of Nikolskoye village. Only 5.1% of the animals have been tagged there.

The sea-otter rookeries on capes Tolstyi and Severo-Zapadnyi are predominantly male ones (see table 2). The Zapadnyi [literally Western] sea-otter rookery can be characterized as a mixed one, with males predominating. The rookery on Cape Nepropusk consists mainly of females.

The percentage of tagged males amounted to 85.9% and that of females 14.1% on Bering Is. as a whole during the winter tagging season of 1986—1987. The overwhelming predominace of males among the sea otters tagged on Bering Is. is due to the inaccessibility of the principal female rookeries in the vicinity of capes Monati and Tonkyi during the winter.

From December 1984 to April 1987, 78 tag returns were collected as a result of tag readings, the discovery of dead tagged sea otters, and second-time captures. The overwhelming majority of the sea otters, some more than once, were encountered in the tagging areas. Sixty-two sea otters were encountered at the tagging sites. Sixteen sea otters were encountered beyond their tagging sites. The greatest distance from the tagging site was about 80 km.

During this period, 21 tag returns were collected at the Cape Tolstyi rookery. The percentage of "our" animals in this return was 80.9%. Among the tagged sea otters encountered on Cape Tolstyi, 17 had been tagged at this site, and 4 (19.1%) were from the Severo-Zapadnyi rookery.

Forty-six tagged sea otters were encountered on the Severo-Zapadnyi cape. The percentage of "our" animals was 78.3% (n=36), 6 sea otters (13%) were from Cape Tolstyi, 2 (4.3%) were from the Severnaya [literally Northern] rookery, and 2 (4.3%) were from the Cape Nepropusk rookery.

At the Severnaya rookery, the percentage of "our" returns was 60% (n=3); 2 sea-otters (40%) had moved to this rookery from the Severo-Zapadnyi cape.

At the Cape Nepropusk rookery and in the adjacent area, despite the fact that we monitored this site much more frequently than the rest, we did not encounter a single sea otter that had been tagged at another rookery.

Analysis of the tag return data has shown that the winter congregations of male sea otters on Bering Is. are relatively stable. At the same time, the results of the tagging show that some age categories of males migrate to neighbouring rookeries.

The process of natural migration of sea otters from Mednyi Is. to Bering Is. was confirmed by facts only in 1987, when A.P. Semerinov found a dead male sea otter tagged by us on Mednyi Is. in 1985 in the vicinity of Polovina Bay on Bering Is. That same year, a female sea otter tagged by us on Mednyi Is. in 1984 was noted in the Cape Tolstyi area of Bering Is.

During a survey in July 1987, a male sea otter with a Bering tag on its hind limb was noted on Mednyi Is. The distance from the observers did not allow them to read the tag code number.

The above material is evidence of a continuing exchange of sea otters between these islands. Whereas males constituted most of the migrant sea otters at the beginning of the 1970s, sexually mature females are currently observed among the migrants from Mednyi Is.

Due to insufficient data, it is difficult to say just how strong the flow of migrants between these islands really is. However, there is no doubt

that it can increase the growth rate of the Bering grouping and influence the formation of its age and sexual composition considerably.

As we have already noted, the tagging of sea otters on Bering Is. is carried out mainly at coastal rookeries. Age determination of a sexually mature sea otter on the basis of external characters with an accuracy of ±2 years is a thankless undertaking to say the least. A true picture of the distribution of age categories and their quantitative composition in a population can be derived by tag returns from dead sea otters (the age of dead sea otters is determined from a microsection of the upper tusks, and by the layers of dentine and cement). Mainly animals 8-9 months to a year old are captured on Mednyi Is. During early spring, animals that have just left their "mothers" form bachelor congregations in several places along the coast of Mednyi Is., capes Yugo-Vostochnyi [literally Southeastern], Severo-Zapadnyi [Northwestern] and Popovsky, and in Gladkovskaya Bay. With a wind force of 1-2, these bachelor sea otters leave the shore to forage for 2-3 hours after sunrise.

However, the absence of abodes for observers makes it impossible to take readings of the tags on Mednyi Is. in winter. Considerable distances, sea turbulence and fog make summer observations difficult. Therefore, sea-otter carcasses constitute the main tag returns.

Summary

1. Coastal male sea-otter rookeries retain from 60 to 80% of their composition during the winter.

2. In the vicinity of Cape Nepropusk where females form a permanent congregation in winter, we did not note any migration of animals from neighbouring areas occupied by sexually mature males.

3. In winter, individual males migrate between male rookeries over distances of up to 80 km.

4. In 1987, tag readings and the discovery of a dead male sea otter confirmed that sea otters migrate between Bering Is. and Mednyi Is.

5. The tagging of at least 40% of the sea otters in a grouping is necessary in order to increase the effectiveness of tag returns.

Dynamics of abundance and some ecological characteristics of the Southern Kamchatka sea otter

by S.I. Kornev, S.M. Korneva (Kamchatrybvod)

Purposeful research and protection of Kamchatka sea otters are being conducted on the basis of the joint program developed by KoTINRO, the Kronotsky Reserve and Kamchatrybvod in 1985.

This paper examines the distribution and dynamics of abundance, and the age and sexual composition of the Southern Kamchatka grouping of the sea otter, as well as the effect of various factors on its status.

The material was collected during 1984—1987 on Cape Lopatka from the impediments off Cape Ostrovnoy on its eastern coast to Cape Kambalnyi on the western coast (Fig. 1). A complete survey of sea otters was carried out up to 3 times a month during the winter—spring period, and once a month during the summer—autumn period. The age and sexual composition was determined visually, and by analysis of tagging results and mortality data for 1984-1987. The material on the feeding of sea otters was collected and processed by a method developed by KoTINRO in 1985. Workers of the bioresources laboratory of the Institute of Geography of the USSR Academy of Sciences Far Eastern Scientific Centre, A.G. Bazhan, A.I. Buyanovsky, A.V. Rzhavsky and Ye.A. Ivanyushina assisted with the determination of the species composition of the sea otter's diet., for which we are deeply grateful.

Dynamics of abundance in 1983-1987. Survey data for the summer months of each year are presented for comparison (Fig. 2, A). The largest number of sea otters on Cape Lopatka in recent years (about 1900) was noted in June 1983 during P.S. Vyatkin and V.N. Burkanov's survey from a boat (1986). In 1985, a coastal route survey revealed that the numbers of the sea otter had dropped by more than one-half, as was the case throughout the coastal zone of Kamchatka (Bednykh et al., 1986). Allowing for the possibility that some of the animals may have been missed during

the survey, we should admit that the decrease in their numbers by one thousand on Cape Lopatka and by more than two thousand in all of Kamchatka may have resulted from their migration to other parts of the range.

Fig. 1. Study area and location of sea-otter rookeries

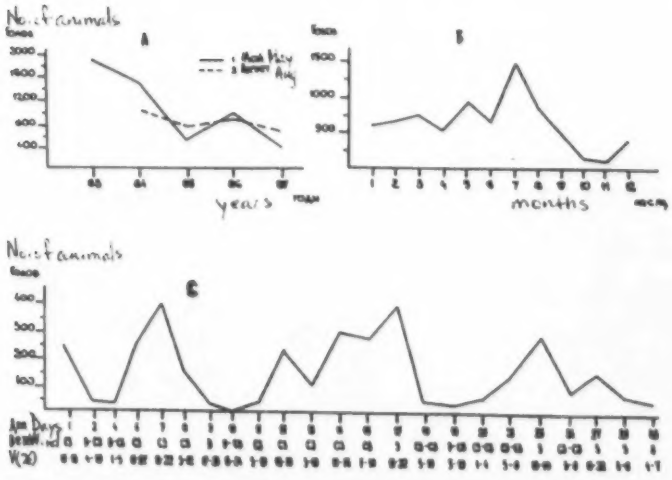

Fig. 2. Dynamics of abundance of sea otters on Cape Lopatka:
A - in 1983-87; B - in 1986; C - in January 1987 at the Yuzhnyi [Southern] rookery

The oneness of the Northern Kurile and Southern Kamchatka sea-otter populations was confirmed by the report of Sakhalinrybvod inspector V.I. Gaidukov (1987) that two dead animals tagged on Cape Lopatka in March 1985 had been found in May and June of the same year on Shumshu Is. However, since the tagging of sea otters on the Kamchatka Peninsula and the Northern Kurile Isls. is not being conducted on a wide scale, it is impossible to determine the regularities of these migrations at the present time.

During 1985-1987, 600-900 sea otters were counted on Cape Lopatka. In 1987, which we believe was the most severe year for Southern Kamchatka as to hydrometeorological conditions, we noted a significant decrease in sea-otter numbers from 600 in winter to 200-300 in spring—summer. In our view, such a sudden drop in the number of sea otters cannot be attributed to mortality alone, since the latter also decreased in 1987, though compared with other parts of the range of this species, its mortality rate on Cape Lopatka is still the highest. As long-term observations have shown, the impression of a higher than usual mortality rate here is formed by the sea-otter carcasses that are cast out on shore from a large part of the range, including the Kurile Isls.

Seasonal variations in abundance. As on the Kurile Isls. (Nikolayev, 1969), the abundance of sea otters in the southern part of the Kamchatka Peninsula undergoes seasonal variations (Fig. 2, B). During certain years, both a similarity and a difference may exist in the distribution of abundance.

During the winter, we observe a significant increase in the number of sea otters in comparison with the autumn period. This is probably due to the approach of animals from the northern parts of Kamchatka. The majority of sea otters gathers on the eastern coast of the peninsula, which is due to the prevalence of northwesterly and westerly winds and favourable ice conditions during this period. In 1986, for example, 500-700 sea otters were counted on all of Cape Lopatka during the winter, and over 90% of these were found on the eastern coast. In the months that followed (February, March), the sea otters spread out uniformly along the western and eastern shores of the peninsula. Throughout the winter of 1987, 90-100% of the entire Southern Kamchatka grouping, which

numbered 1000 in January, was found in the southeastern part of Cape Lopatka, including the First Kurile Strait.

An increase in sea-otter numbers is observed from May to August during any year; at this time, the majority of the animals (70-100%) congregate on the western coast. Their migration to the western side of the peninsula in summer is due to the decrease in the wind frequency of the fourth quarter, and the absence of persistent westerly gales. However, the overall increase in abundance during the summer period can be attributed to the migration of the sea otters to Southern Kamchatka from the Kurile Isls. For example, in June 1986, large congregations of up to 1500 sea otters were noted off capes Kambalnyi, Predsopochnyi and Kitovyi (Western rookery).

During the summer—autumn period (August—November), about 150-200 sea otters remain near the coast of Cape Lopatka, as has been observed over a number of years. The onset of autumn is characterized by good meteorological conditions which allow the sea otters to spread out and migrate far from the shore in search of food. The surveys during this period usually give low results, which is also the case for the Kurile Isls. (Gaidukov, personal communication).

Monthly variation of abundance. Daily observations on the distribution and abundance of sea otters were conducted at the Yuzhnyi [Southern] rookery in December 1986 and January 1987. We found that the nature of the variations of both indices depends on the direction and velocity of the wind (Fig. 2, C). The influence of wind as an environmental factor increases when accompanied by precipitation and sea turbulence.

Throughout the year, winds of the fourth quarter prevail on Cape Lopatka (up to 40-45%). Winds of these directions with a velocity exceeding 15 m/s (often up to 40 m/s) occur more than 70% of the time in winter. With a moderate wind (5-10 m/s) of any direction, only individual sea otters are encountered off Cape Lopatka. On calm days, the animals probably forage actively, remaining close to the foraging grounds to rest. As the northwesterly—westerly winds grow stronger (to15-20 m/s), the number of sea otters off the Yuzhnyi rookery increases. In this type of weather, many of the animals prefer to stay in the water in groups. A wind exceeding 20-25 m/s, often with precipitation, results in a mass

haul-out of sea otters on the leeward side. During this period, the animals usually remain on the shore for several days.

As shown in Fig. 2 C, the numbers of the sea otter at the Yuzhnyi rookery grow as the winds of the 4th quarter increase, and drop as the winds die down (cease). The appearance of animals on the western coast of Cape Lopatka coincides with the change in wind direction on the eastern coast.

A similar situation is noted in other resting places of sea otters on capes. On the other hand, small islands provide good protection for the animals regardless of wind direction.

Effect of ice conditions on the distribution of sea otters. Severe ice conditions for sea otters are rare in the vicinity of Cape Lopatka. Drifting very open or open pack ice, first-year ice cakes, or strips of young ice and separate floes, which are carried from the Sea of Okhotsk to the western coast of Cape Lopatka by the prevailing northwesterly and westerly wind and current, appear for 1.5-2 months mainly in the middle or at the end of January. The ice is carried from the Sea of Okhotsk and Avacha Bay to the eastern coast via the First Kurile Strait. During certain years, there is no ice at all, or else it remains near Cape Lopatka for several days.

Since the appearance of drifting ice greatly affects the behavior of the sea otters and alters their distribution (Nikolayev, 1969, 1973; Maminov, 1975), it would make sense to examine this in greater detail.

Over the past four years, ice accumulated in large quantity on the western coast of Cape Lopatka from the middle of January to March only in 1987. Because of this, the sea otters stayed mainly on the eastern coast where the concentration of ice did not exceed 4-5. The animals stayed on the ice-floes in ones, less commonly in twos and threes. A strong wind carried the ice-floes away from the shore for tens of kilometres towards the ocean or into the Sea of Okhotsk, depending on the direction of the wind. In the case where wind velocity was insignificant, the passive migration of the sea otters was determined mainly by the currents. During this period, the animals hardly ever hauled out at the coastal rookeries, preferring to stay on the ice-floes where they could take turns feeding and resting.

The formation of close pack ice or difting compact pack ice (noted at the end of February 1987) pushes the majority of the sea otters out towards the Kurile Isls. Some of the sea otters "settle down" on the southeastern side of Cape Lopatka where there are always ice-free areas of water and enough room for maneuvering if the ice drift happens to change. However, an abrupt change in ice conditions, when gale winds cause the ice to compact and push it against the shore, forces some of the animals, predominantly the young ones, to haul out. For example, on Cape Perelaz on 27 February 1987, three sea otters found themselves "cut off" from the water by a strip of compressed ice and slush up to 500 m in width after a strong easterly wind (30 m/s). Two of the animals tried to reach the water via a sticky mass of wet snow, while the third sea otter crossed the cape from east to west, covering a distance of more than 3 km.

Age and sex composition. In 1983, 323 female sea otters with pups (12% of the total numbers) were counted at the southern end of the Kamchatka Peninsula (Vyatkin, Burkanov, 1986). It is interesting to note that among the sea-otter carcasses found on Cape Lopatka in 1984, the ratio of females was the same. Among the carcasses found in 1985-1987, females constituted 4.3-5.5%, and juveniles and underyearlings 3-8.7%. Naturally, the sex and age ratios among the dead animals do not reflect the true structure of the population, as the mortality rate may be sex-selective. A more trustworthy result can be obtained by studying tagged animals (table 1).

Table 1. Age and sexual composition of sea otters tagged on Cape Lopatka

Years	Males		Females		Adults		Juveniles		Underyearlings	
	n	%	n	%	n	%	n	%	n	%
1985	21	95.5	1	4.5	19	86.4	1	4.5	2	9.1
1986	40	93	3	7	34	79	4	9.4	5	11.6
1987	13	86.7	6	7.5	63	78.8	8	10	9	11.2
Total	74	92.5	6	7.5	63	78.8	8	10	9	11.2

Tagging was carried out at coastal rookeries during the winter—spring period in 1985-1987. Considering that the females at the rookeries during this period are mainly young ones and underyearlings, the number of mature reproductive females will correspond approximately to the number of underyearlings. Totalling the tagged young sexually immature females and underyearlings (in %), we get a female/male ratio equal to 13.6% for 1985, 18.6% for 1986, and 26.6% for 1987. If we take into account the females with their young that were counted during tagging in the water, the sex ratio will average 5:1 or close to that. The predominance of male groupings in the vicinity of Cape Lopatka has to do with the severe climatic conditions there; the females with pups prefer to stay in the more sheltered areas of the coast, which are slightly farther north.

Analysis of the sea-otter diet. Analysis of the excrements collected during the winter of 1986-1987 (December—February) at coastal rookeries, enabled us to establish the species composition of the sea otter's diet and feeding dynamics in the Cape Lopatka area. The frequency of occurrence and the volumetric ratio of the various food groups in the diet of the sea otter vary somewhat throughout the winter (table 2).

Table 2. Changes in the composition of the sea otter's winter diet on Cape Lopatka in 1986—1987

Food groups	December		January		February	
	Times encountered n = 38	Volume in food bolus, %	Times encountered n = 26	Volume in food bolus, %	Times encountered n = 16	Volume in food bolus, %
Sea-urchins	92.1	64	69.2	52	25	16
Mollusks	63	10	81	17	81.2	36
Crustaceans	60	15	19.2	11	31	18
Inclusions (algae, pebbles, own fur)	0.6	11	65	20	62.5	30

The predominance of sea-urchins and bivalve mollusks in the diet of the sea otter is most probably due to their abundance and background-forming importance in the benthic communities of Southern Kamchatka. The species diversity of the food items consumed by the sea otter is fairly well-defined. The sea-urchins in the sea otter's diet are represented by three species, but *Strongylocentrotus polyacanthus* is the preferred species. The frequency of its occurrence in the excrements of the sea otter is 71%; the frequency of occurrence of *S. droebachiensis* is 23.8%, and the flat *Clypeastroida* sp. has been encountered only once. Of the bivalve mollusks found all winter, *Modiolus modiolus* constitutes 42.5%, *Mytilus edulis* 8.75%, and *Hiatella arctica* 10% of the diet. The number of mollusks of the infauna in the sea otter's diet increased at the end of January and in February with the addition of the following species: *Pododesmus macrochisma* (6.25%), *Seliqua alta* (3.75%), *Macoma* sp. (6.25%), *Peronidia lutea* (3.75%), and *Mya* sp. (2.5%). The assumption that these food items may be accessible to the sea otter during winter gales (Sidorov, Burdin, 1985) has been confirmed by our data. The largest number of crustacean species was noted in December; they included the spiny and Kamchatka crabs of the genus *Paralithodes* sp. (17.5%), the snow crab *Chionoecetes opilio* (1.25%), *Dermaturus mandti* (2.5%), *Balanidae* sp. (1.25%), and *Hippolytidae* sp. (7.5%). A significant number of hairy crabs, *Telmessus cheiragonus* , was encountered at the end of February (43% of the total excrements of that month), but no other Decapoda were observed. Gastropods were represented by individual specimens of the genus *Acmae* in all the cases. The occurrence and volumetric ratio of brown and coralline algae in the sea otter's diet increases by the end of winter. The presence of accidental inclusions in the excrements, namely small pebbles and grit, is probably the result of feeding on bivalve mollusks with their byssi, which the sea otters swallow. An increase in the amount of the sea otter's own fur in the food bolus by the end of February is an indication of more intensive moulting than at the beginning of winter when hair replacement basically ceases.

Anthropogenic factors. According of Odum's classification (1986), the effect of man's activity on the ecosystem can be divided into two arbitrary groups, 1) "acute stresses" (brief exposure), and 2) "chronic stresses"

(continuous disturbing exposure). The first group for the Southern Kamchatka sea otters includes a single approach of a vessel, a plane or helicopter flying by, a brief visit of the rookeries by man when the animals are present; the second group includes the aftereffects of man's economic activity.

The passage of vessels near the habitats of the sea otters without the dumping of any contaminants in the area should be regarded as brief exposure which does not have any significant effect on the condition of the animals. We have often observed that sea otters, though they do display cautious behavior on the approach of vessels and motor boats, quiet down shortly after they have passed. Aircraft flying at a low altitude usually frighten off the sea otters, even when flying by at some distance away from the animals. However, flights over Cape Lopatka by special aircraft are a rare occurrence, which means that this factor also falls into the first group. The animals are rarely frightened by man at rookeries, since the latter are monitored regularly by an inspector and are far from any populated area.

"Chronic stress" is caused mainly by pollution of the water areas. Fish protection authorities annually find evidence of petroleum residue, diesel fuel and other industrial waste being dumped by various sea transport vessels close to the habitats of sea otters in the southern part of the Kamchatka Peninsula and in the vicinity of the Northern Kuriles. In 1986—1987, there were five major cases of contamination near Utashud Is., Avacha Bay and Cape Lopatka. Unfortunately, very few of these violations of the Sea Mammal Protection Regulations are uncovered, and as a result of this pollution of the ocean, many animals have died. For example, in May 1987, an emaciated harbour seal whitecoat with soiled fur was found dead on the eastern reefs of Cape Lopatka, and a sea-otter carcass in the same condition was found at the Yuzhnyi rookery in June of the same year. Two sea otters and a male harlequin duck were found dead in the winter of 1986 as a result of direct contact with petroleum products.

Thus, the pollution of coastal waters near the places inhabited by sea otters should be regarded as exposure that leads to inevitable consequences for this species.

As we have seen, the dynamics of abundance and the distribution of sea otters off Southern Kamchatka depend on numerous abiotic and anthropogenic factors. Our brief study of the diet of the Southern Kamchatka grouping of sea otters does not allow us to conclude at present how the overall status of this species is affected by its food resources.

Over the past four years, there has been a significant decrease in the abundance of sea otters, due to their migrations to other parts of the range. However, their exact destinations and their migrational tendencies have not been completely established because of the absence of a simultaneous nationwide survey of sea otters throughout the coastal areas and islands suitable for this species.

The areas of distribution of the Southern Kamchatka and Northern Kurile groupings of the sea otter interpenetrate; therefore, the organization of systematic retrieval of data on the status of this species on the Kurile islands adjacent to Kamchatka will contribute to a more detailed study of these two groupings.

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Sea otter of the Kurile Isls.

Dynamics of abundance, diet, and intraspecific status

by M.K. Maminov (TINRO)

A study of the dynamics of abundance and the distribution of the sea otter in the 1970s showed that by the beginning of the 1980s, these animals had colonized virtually all of the Greater Kuriles. They were not found only off the coast of Kunashir Is. Individual sea otters appeared occasionally on the lesser islands of the Kurile chain. The numbers of the sea otter on many of the large islands of the Kurile chain remained relatively stable. A slight increment of the herd was observed only on the islands of Iturup and Shumshu. The total sea-otter stock in this region was estimated at 5500-6000 at the beginning of the 1980s (Kuzin et al., 1984).

TINRO and Sakhalinrybvod conducted a survey of sea otters from 1980 to 1987. During this period, no particular changes were noted in the distribution of this animal. However, the abundance of sea otters changed significantly from 7500 in 1982 to 5500 in 1984. The noted yearly fluctuations were due largely to the irregular local migrations of the animals from the southern coast of the Kamchatka Peninsula to the northern group of the islands (Paramushir and Shumshu) and back. This is confirmed by the drastic changes in the numbers of the sea otter (almost doubled) off the coast of Paramushir Is. In fact, it was in 1982 that the highest increment in sea-otter numbers was noted here. At the same time, there was a drastic (3-fold) drop in the numbers of the sea otter off the southern coast of the Kamchatka Peninsula, according to the data of Sakhalinrybvod workers. In the following years of the survey (1984,

1986), the numbers of the sea otter off the coast of Paramushir Is. returned to the initial 2000-2500 (Kuzin et al., 1984). The same was apparently responsible for the fluctuations in the abundance of the sea otter off the coast of Shumshu Is., where it varied from 600 to 1000 (average 700) individuals in summer during the 1980s.

In the rest of the coastal area of the Kurile chain, the numbers of the sea otter in summer from 1980 to 1987 remained relatively stable everywhere, amounting to 300-400 individuals in the Makanrushi-Shiashkotan group of islands, 400-450 on the Matua-Simushir islands, 2000-2300 on the islands of Urup and Chernyye Bratya, and 600-700 on Iturup Is. On some islands (Urup and Shumshu), the absence of an increment in sea-otter numbers was confirmed by the results of both summer and winter—spring surveys.

On the whole, the stabilization of sea-otter numbers over many years brings us to the conclusion that the replacement of the sea-otter stocks within the Kurile chain of islands was completed by the beginning of the 1980s.

Our study of the seasonal dynamics of sea-otter abundance has helped to establish that the total numbers of this species within the Kurile chain of islands peaked in summer, and were the lowest during the winter—spring period. As in the majority of long-lived species, the seasonal variations in the numbers of the sea otter were due mainly to the changes in the number of pups, while the numbers of the adult stock remained practically unchanged (Formozov, 1983). True, the numbers of the adult stock of sea otters off the coast of Shumshu Is. also underwent seasonal changes.

Such deviations from the general tendencies, as well as the drastic fluctuation in sea-otter numbers (more than 2—3-fold off the coast of Shumshu Is. during the winter—spring period), are due to local migrations of the animals from neighbouring coastal areas of Paramushir Is. and the Kamchatka Peninsula. We have repeatedly observed the migration of large groups of 50-60 sea otters from the coast of the Kamchatka Peninsula to Shumshu Is. The causes of these migrations are not always clear. Apparently, these local migrations are prompted largely by changes in hydrobiological conditions.

Feeding. The qualitative and quantitative composition of the food consumed by the sea otter of the Kurile Isls. was studied by analysis of the excrements (for the winter—spring period) and analysis of the stomach contents (for the summer—autumn period). Altogether, we analyzed the contents of 1300 excrements and 175 stomachs with food remains.

We found that the summer diet of the sea otters inhabiting the coast of various islands has been fairly specific over the past ten years. On the islands of Paramushir and Onekotan, the sea otter's diet consisted mainly of bivalve mollusks (*Modiolus modiolus* , *Peronidia lutea*) and species of the genus *Cerripes* (45-48%), as well as fish egg deposits (15-26%) (in weight ratio of the foods consumed).

In the southern part of the Kurile chain of islands (Urup and Iturup), the summer diet of sea otters consisted mainly of fish and fish egg deposits (55-75%), as well as octopuses (13-26%).

In the central part of the Kurile chain of islands (Simushir Is.—Rasshua), the summer diet of the sea otter consisted of octopuses (58%) and sea-urchins (25%). In addition to that, the sea otters off the coast of Paramushir Is. consumed large quantities of ascidians (*Ascidia pelonaja* - 20.9%), while on Iturup Is. they fed on bivalve mollusks (the species could not always be determined).

Our study of the yearly changes in the foods consumed by the sea otter of the Kurile Isls.was based on analysis of excrement. It appears that the composition of the sea otter's diet on some of the islands has undergone significant changes over the past 10-15 years. For example, in the 1980s, the content of sea-urchins in the diet of the sea otters of Paramushir and Irurup decreased 2—2.5-fold in comparison with the 1970s, and the content of bivalve mollusks of the genus *Modiolus* decreased 2—6-fold. During the same period, the assortment of foods amost doubled in the diet of the Urup population of sea otters as well. At the same time, the importance of ascidians and cerripeds in the sea otter's diet increased substantially.

The observed yearly changes in the composition of the sea otter's diet are probably an indication of diminishing food resources.

Intrapopulational structure of the sea otter. Our study of the dynamics of abundance and the geographic variability of some of the

morphoecological characters of the sea otter has shown that each large island grouping of animals within the Kurile chain of islands is characterized by its own typical surroundings. The presence of barriers in the form of wide and deep straits, and the morphoecological distinctiveness of certain islands groupings of the sea otter have led us to believe that at least four independent populations exist within the Kurile chain of islands, namely the Iturup population which is restricted in size by the size of the island itself, the Urup population which is probably formed by the sea otters of the Urup and Chernyye Bratya islands, the Paramushir population which is formed most likely by the sea otters of Paramushir Is., Shumshu Is. and the southern part of the Kamchatka Peninsula, and the Simushir—Onekotan population which includes the sea otters of the small islands in the central part of the Kurile chain.

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APPENDIX

Statistical data on the harvesting of sea mammals in the Bering and Chukchi seas during 1986-1987 (number of animals)

Species	Hunting area	Hunting method	1986	1987
Ringed seal	Bering Sea	From a vessel	984	257
		Coastal	1812	868
	Chukchi Sea	Coastal	3323	3296
Harbour seal	Bering Sea	From a vessel	1200	1625
		Coastal	185	408
	Chukchi Sea	Coastal	96	35
Bearded seal	Bering Sea	From a vessel	613	428
		Coastal	1087	971
	Chukchi Sea	Coastal	518	331
Ribbon seal	Bering Sea	From a vessel	4000	4000
Walrus	Bering Sea	From a vessel	1063	1699
		Coastal	2041	1584
	Chukchi Sea	Coastal	780	766
Grey whale	Bering and Chukchi seas	Coastal	168	154

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